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THE UNIVERSITY OF KANSAS
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Vol. XXXVI, Pt. II] July 15, 1954 [No. 10

The Subspecies of the Ring-necked Coffee Snake, *Ninia diademata*, and a Short Biological and Taxonomic Account of the Genus

W. Leslie Burger and John E. Werler [1]

Abstract: *Ninia*, a genus of neotropical snakes, is briefly characterized, and available ecological information on it, summarized. An annotated list of the 13 recognized forms presents a new arrangement of species and subspecies. Two of the names used for them are new combinations: *Ninia lansbergi* (which replaces *Ninia atrata*) and *Ninia maculata tessellata.* The variation and distribution of the four subspecies of *Ninia diademata* are treated in special detail, as one of them (*Ninia diademata labiosa*) is resurrected and another (*Ninia diademata nietoi*) described as new. Diagnostic information is summarized to assist identification of any snake of the genus.

INTRODUCTION

In a short paper published in 1935, Dunn characterized the genus *Ninia* and laid a firm taxonomic foundation by diagnosing the species discernible at that time. He listed five monotypic species. In the meantime, information scattered in several dozen publications has more than doubled the number of recognized forms and has greatly augmented knowledge of them all.

Our own studies, resulting in the addition of one new subspecies of *Ninia diademata* and the resurrection of another, required a detailed consideration of the variation in all the populations of that species and a survey of all recent literature pertaining to the genus. We thus take this opportunity to summarize the genus with a short general characterization and a briefly annotated list of the currently recognized species and subspecies. The species are arranged in the order in which they appear geographically, from south to north, and subspecies within each species in the same order.

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[1] Department of Zoology, University of Kansas, and San Antonio Zoological Society, respectively.

Numbers 2, 3, 6, 8, and 12 are the species listed by Dunn; but the first of them appears here as *N. lansbergi* instead of *N. atrata*. The others are forms generally recognized for the first time after 1935; they include four revivals (numbers 4, 5, 7, and 11, the last effected here) and four novelties (numbers 1, 9, 13, and 10, the last described here).

Each form has a skeleton synonymy that consists of the following references only: (1) the type description; (2) synonyms; (3) names used in several of the most important references up to and including Dunn's 1935 synopsis; and (4) publications from the interval from 1935 to 1953, inclusive, and a few from 1954.

The generic synonymy is relatively simple, for only one extra name has been applied to the genus.* A year after Baird and Girard (1853: 49) described the new genus *Ninia,* Duméril, Bibron, and Duméril (1854: 514) erected *Streptophorus* for the same group. The first genus had only one species, *diademata,* which automatically functions as its type. The second genus contained four species. Since originally no genotype was designated for it, Dunn (1935: 10) selected *bifasciatus* (=*diademata*) as the type. In the early systematics of these snakes the two generic names were used alternately by different writers. Here we have made no special effort to include the extra name combinations that resulted from transfers in generic names, since their application is immediately apparent.

An account of the variation of the subspecies of *Ninia diademata* and an outline to assist identification of any snake of the genus is included at the end of our paper.

ACKNOWLEDGMENTS

We owe very special notes of thanks to Drs. Hobart M. Smith and Edward H. Taylor for assistance, advice, and encouragement, and to Dr. L. C. Stuart for advice and for the gracious gesture of turning over to us for study, data and specimens of a Guatemalan subspecies, originally presumed to be new, but ultimately determined to be the long-buried *labiosa* of Bocourt. For the line drawings (figs. 1 and 2), we are indebted to Donald M. Darling. The excellent libraries of the universities of Illinois and Kansas and of Dr. Hobart M. Smith, and the extensive resources of the University of Illinois Museum of Natural History and of the University of Kansas Museum of Natural History have been of great assistance. Dr.

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* In addition *Ninia psephota* was originally placed in the genus *Catastoma* (= *Rhadinaea*) and *N. atrata* (= *N. lansbergi*) in *Coluber*.

Jean Guibé of the Museum d' Histoire Naturelle, Paris, was very helpful in furnishing information on type specimens of the ninias described by Bocourt and by Duméril, Bibron, and Duméril. Dr. Doris M. Cochran contributed valuable information on a USNM specimen collected by Sumichrast.

Most of the hundred odd specimens that are herein reported were borrowed. For the privilege of examining these specimens we thank the following persons and their associates in the respective museums: Mr. Clifford H. Pope of the Chicago Natural History Museum (CNHM), Messrs. Arthur Loveridge and Benjamin Shreve of the Museum of Comparative Zoology (MCZ), Drs. Hobart M. Smith and Donald F. Hoffmeister of the University of Illinois Museum of Natural History (UIMNH), Drs. Edward H. Taylor and E. Raymond Hall of the University of Kansas Museum of Natural History (UKMNH), Dr. Norman Hartweg and Mr. William E. Duellman of the University of Michigan Museum of Zoology (UMMZ), and Dr. Doris M. Cochran of the United States National Museum (USNM). In addition, we will mention specimens from several other collections: Academy of Natural Sciences of Philadelphia (ANSP), British Museum (BM), E. H. Taylor-H. M. Smith Collection (EHT-HMS), Louisiana State University (LSU), Museum d' Histoire Naturelle, Paris (MHNP), Naturhistorischen Museum in Hamburg (NMH), University of Notre Dame (UND), Zoologisches Museum der Humboldt-Universitat, Berlin (ZMB). The abbreviations cited above will serve to identify the respective institutions, when their specimens are cited.

ECOLOGICAL LIFE HISTORY NOTES ON THE GENUS

To naturalists entering the range of *Ninia* from more northern parts of the Western Hemisphere, the general habitus, the kind of environment favored, and the behavior of these small snakes will recall members of the genera *Storeria* and *Diadophis*. While the natural history of its two North American analogs is fairly well known, such information about the Central American genus is extremely fragmentary. We hope the following brief account will help direct attention to this unfortunate hiatus.

Distribution. Ninias appear generally to have rather extensive geographic ranges and somewhat restricted altitudinal ranges, with certain exceptions to both. In the north, *Ninia d. diademata* is a foothill species, occurring principally in the coffee life area of the upper tropical zone, 1,500-3,500 feet in altitude; its Hidalgoan conspecifer, *plorator,* ascends mountains to a much higher altitude, approximately 8,000 feet; its Pacific slope conspecifer, *labiosa,* is restricted to the coffee life area; its Caribbean slope conspecifer, *nietoi,* occurs in the lower as well as the upper tropical zone. At least in the northern part of its range, *Ninia s. sebae* is widespread at almost every altitude, but occurs in greatest abundance in the coffee life area. The altitudinal distributions of the southern species are less well known. Certain of them, *N. psephota* and *N. oxynota* for instance, may be restricted to higher altitudes, of 4,000 feet or more; and certain others (perhaps *N. hudsoni*) to low elevations. At least *N. lansbergi* has an extremely wide range of altitudinal distribution. Several ninias—*N. d. plorator, N. d. labiosa, N. s. morleyi,* and *N. psephota*—are each known from less than half-a-dozen restricted areas. *N. hudsoni* is known only from one locality.

Habitat and activity. All of the species seem to favor a leaf mold, under-log, or under-rock habitat from which they seldom emerge, even at night. The senior author's experience with several species in Chiapas during the rainy season is typical. In areas where both *Ninia s. sebae* and *N. d. diademata* could be found in abundance under logs, neither search by day nor collecting with lantern at night revealed any individuals foraging on the surface.

On occasion these snakes utilize other types of cover, and under some conditions they emerge into the open. Mole (1924: 241) wrote that a specimen of *N. lansbergi* was found in a bamboo clump on Trinidad. Smith (1943: 456) reported finding *N. s. sebae* in the axils of dead palm trees in Chiapas. In Campeche, Smith (1938: 19) found specimens of *N. s. morleyi* crossing a trail at night and in shaded woods beside the trail during the morning. At Piedras Negras on the Mexico-Guatemala border, he (1943: 456) found a specimen of *N. d. nietoi* at night along a forest trail. Shannon (1951: 482) told about two specimens of *N. s. sebae* found late in the day (8:00 P. M.) on a large rock extending into the river in the center of San Lucas Camotlán, Oaxaca.

Concerning *N. s. sebae,* Stuart (1950) commented (1) that its occurrence is directly correlated with the amount of ground litter; (2) that its abundance in the coffee belt probably is due to the abundant litter there; and (3) that only one type of mulch appeared to be definitely avoided, that in which rotting banana plants occurred.

Because of their abundance in the altitudinal life belt where coffee is grown, certain of these snakes have been known colloquially by the name *culebra café* which, by literal translation, means *coffee snake.* Here we have coined common names by applying descriptive and geographic adjectives to the English version of this name.

Food and enemies. Not many instances of predation either by or on coffee snakes are on record in the literature. Taylor (1949: 195) found small slugs in stomachs of *N. d. plorator.* Slevin (1942: 469) found elytra of beetles in stomachs of *N. psephota.* Schmidt (1932: 7) found specimens of *N. s. sebae* in the stomachs of *Micrurus nigrocinctus nigrocinctus.* According to Boulenger (1913: 1021), the holotype of *Caecilia intermedia* (a synonym of *C. nigricans* according to Dunn) was obtained from the stomach of a *Ninia lansbergi,* which in turn had been eaten by a *Micrurus transandinus.*

Breeding. Stuart (1948: 77) wrote that, in Alta Verapaz, *N. s. sebae* ". . . reaches maturity, as indicated by the presence of eggs in the females and breeding tubercles on the chins of males, when a total length of about 250 mm. is attained. The breeding season is apparently extensive. Females taken from March to June had eggs in their bodies, and a juvenile captured in early June showed the umbilical scar. Adult males taken during the same period all possessed well-developed breeding tubercles." Approximately a degree to the north, in an area about 15 miles south of Pichucalco, Chiapas, the senior author found 16 eggs of this species in a moist cavity beneath a log. The eggs were scattered in clusters of 4, 4, 3, 3, and 2, each possibly representing the clutch of a single female. They were discovered on August 20. In the next four days seven of them hatched. The young snakes, preserved soon after hatching, measure as follows (total length in mm.): 123, 126, 126, 127, 127, 128. 128. Subsequent examination of the remaining eggs showed that they had spoiled. Perhaps another three degrees to the north of the aforementioned area, on the Yucatán Peninsula, females of *N. s. morleyi* taken on July 13 and 14 contained eggs (Gaige, 1936: 298).

Defensive behavior. When sufficiently annoyed, a captive specimen of *N. s. sebae* responded repeatedly by flattening horizontally the forepart of the body. This behavior was not demonstrated by the type of *N. d. nietoi,* which also was frequently handled when alive. Dunn (1935: 10) mentioned the same behavior, which he presumably observed in *N. sebae, N. diademata, N. maculata,* and *N. psephota.*

BRIEF CHARACTERIZATION OF THE GENUS

Internal morphology. Dunn (1935: 9) tersely summarized the distinctive aspects of the anatomy of the genus *Ninia:* "Small colubrid snakes with hypapophyses on all body vertebrae; hemipenis with sulcus forking proximally, with proximal hooks and distal calyces, the areas so furnished about equal in extent, calyculate area with free proximal edge (capitate) and divided so that the organ is somewhat bifurcate; maxillary teeth 15-18, subequal, mandibular teeth subequal . . ." Cope (1896: pl. 25, fig. 10) figured the hemipenis of a specimen of *N. sebae sebae* (called by him *N. atrata*) from Mexico.

External morphology. Head only slightly greater in circumference than the neck, and not especially broad or flat. Except for the absence of a preocular scute (frequently represented by one or several small scales that occasionally separate the loreal from the eye) there is a full colubrid complement of head scales: a normal rostral followed above by two internasals, two prefrontals, a frontal bounded laterally by single supraoculars, and two parietals; on each side a pre- and postnasal, a loreal, several postoculars (usually two, but not uncommonly more and occasionally only one or none), a well-differentiated anterior temporal, followed by two tiers of undifferentiated head scales, which may or may not be considered temporals; on the chin a mental followed by the first infralabials which adjoin medially, a pair of large anterior chinshields, and a pair of smaller posterior chinshields. In adult males the mental, first infralabials and anterior chinshields have prominent spiny tubercles; in young males chin tubercles are much less prominent, and only occasionally are any at all evident in females. The dorsal scales are strongly keeled. Scales in the lower two rows on each side are larger than the other scales and have lower keels. In addition, all of the dorsal scales are finely striate and the striation overlaps onto the edges of the ventrals of most species. The above features are fairly constant and their occasional variation appears to us to be anomalous in nature and of little, if any, taxonomic or geographic significance. They are present in the holotype of the Caribbean subspecies, *Ninia d. nietoi,* but are not repeated in its type description.

The dorsal scales are in 19 rows throughout the body except in two species (*N. psephota* and *N. oxynota*) that normally have 17, and in occasional variants of the other species that differ by having lost or gained a row of scales on either or both sides. The supra- and infralabials are usually of the same number and this number is fairly constant in most species and subspecies, though even in these forms loss or gain of one plate is not uncommon. One subspecies (*N. d. labiosa*) has labials divided in frequency almost equally between the numbers five and six. The labials of the other species and subspecies normally number either six (3 species) or seven (4 species). The total range of variation of ventrals in the genus is from 123 to 164, that of caudals from 34 to 106. The loreal is most often elongate, one and one-half to two times as long as high; in several forms it is approximately the same in both dimensions.[2]

One species (*N. hudsoni*) is reported to have all the upper head scales striated. These features (Table 2) along with coloration (outline at end of paper) distinguish the different species and subspecies.

Phylogeny. Phylogenetic consideration of the species and subspecies of *Ninia* probably should await additions to our knowledge of their variation and distribution. We hope the following summarization will contribute to that end.

ANNOTATED LIST OF SPECIES AND SUBSPECIES

1. *Ninia hudsoni* Parker

Guiana Coffee Snake

Ninia hudsoni Parker, Ann. Mag Nat. Hist., ser. 11, vol. 5, 1940, pp. 270-271 (type locality, New River, southern British Guiana, altitude of 750 feet; type, B.M. No. 1939.1.1.9).

In the above cited description Parker wrote: "This form is obviously very closely allied to *N. atrata* [= *N. lansbergi*] and may be found to be a southeastern race which intergrades with the typical form." We are aware of no other references to it.

2. *Ninia lansbergi* (Duméril, Bibron, and Duméril) [new comb.]

South American Coffee Snake

Coluber atratus Hallowell,[3] Proc. Acad. Nat. Sci. Philadelphia, vol. 2, no. 9, 1845, p. 245 (type description, "Republic of Columbia [*sic*], within 200 miles of Caracas," now included in Venezuela; types, A.N.S.P. Nos. 3410-2[4]).

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[2] The homology, and hence the correct terminology of the plate that we here call the loreal, is somewhat obscure to us. Apparently current practice is to call a single plate between nasal and eye the loreal if it is elongate, or the preocular if it is high. In *Ninia* both conditions are represented. Since the elongate shape is more prevalent, to avoid confusion here, we consistently term this plate *loreal*, regardless of its relative proportions.

[3] According to the rules of zoological nomenclature, this name is not available since it is a primary homonym of a name published 77 years earlier. For details see our discussion of the species.

[4] A fourth cotype was mentioned in the type description, but its present whereabouts is unknown.

Streptophorus Lansbergi Duméril, Bibron, and Duméril,[5] Erpétologie générale . . ., vol. 7, 1854, pp. 518-519 (type locality, Caracas, Venezuela; type, M.H.N.P. No. 3446, ♀ 147 V + 46 C); Bocourt, Mission Scientifique au Mexique . . . Reptiles, livr. 9, 1883, pp. 551-2, pl. 32, fig. 9a-b.

Streptophorus Drozii Duméril, Bibron, and Duméril, Erpétologie générale . . ., vol. 7, 1854, p. 518 (type locality, "Nouvelle-Orleans", certainly in error; type, M.H.N.P. No. 3444, ♀150 V + 52 C).

Streptophorus sebae Schmidti Jan, Arch. Zool., vol. 2, 1862, p. 27 (type locality, Guayaquil, Ecuador).

Streptophorus spilogaster Peters, Sitz. Ges. Nat. Fr., 1881, p. 49 (type locality, "Ecuador").

Streptophorus seba var. *atratus,* Bocourt, Mission Scientifique au Mexique . . . Reptiles, livr. 9, 1883, p. 548.

Streptophorus atratus var. *lansbergi,* Werner, Mitt. Naturh. Mus. Hamburg, Jahrg. 26, 1910, p. 217.

Ninia atrata atrata, Amaral, Mem. Inst. Butantan, vol. 4, p. 151 (distribution); Hermano Daniel, Univ. Antioquia, vol. 24, no. 96, 1950, p. 414 (Colombia); Marcuzzi, Nov. Cient. Mus. Hist. Nat. La Salle (Caracas), Ser. Zool., no. 3, 1950, p. 4 (Venezuela); Alemán, Mem. Soc. Cienc. Nat. La Salle (Caracas), vol. 12, no. 31, 1952, pp. 16-17, fig. 12 (Venezuela); Beebe, Zoologica, vol. 37, pt. 4, 1952, p. 175 (Trinidad).

Ninia atrata, Dunn, Proc. Nat. Acad. Sci., vol. 21, no. 1, 1935, p. 11 (synoptic treatment); Dunn and Bailey, Bull. Mus. Comp. Zool., vol. 86, no. 1, 1939, p. 7 (localities in Panamá and Panama Canal Zone); Brongersma, Studies on the Fauna of Curaçao, Aruba, Bonaire and the Venezuelan Islands, vol. 2, no. 8, 1940, p. 118 (Caracas, Venezuela); Parker, Ann. Mag. Nat. Hist., ser. 11, vol. 5, 1940, pp. 270-271 (variation and geographic distribution); Dunn, Caldasia, vol. 3, no. 12, 1944, p. 197 (distribution in Colombia); Dunn, Ecology, vol. 30, no. 1, 1949, p. 55 (relative abundance in Panamá); Taylor, Univ. Kansas Sci. Bull., vol. 34, pt. 1, no. 1, 1951, pp. 50-51 (Costa Rica); Roze, Bol. Soc. Venezolana Cienc. Nat., vol. 14, no. 79, 1953, p. 206 (Venezuela); Taylor, Univ. Kansas Sci. Bull., vol. 36, pt. 2, 1954, no. 11, pp. 696-697 (Costa Rica; detailed description).

Trinidad, Venezuela, Colombia, and Ecuador; north in Central America to central Costa Rica.

Unfortunately the name, *Ninia atrata,* long used without question for the earliest known species of the genus, must be suppressed. *Coluber atrata,* the combination used by Hallowell in his type description, was used by Gmelin (1768: 1103) for snakes of an entirely different group. In the latter sense (earlier by 77 years), *atratus* applies to several kinds of striped snakes pictured by Seba (1735: pl. 1, fig. 9 and pl. 9, fig. 2) and Gronovius (1756: pl. ?). One of them, probably Seba's plate 1, figure 9, is usually supposed to be *Lygophis lineatus lineatus* (Linnaeus); and the others apparently have not been identified. For present purposes, details of their identity are not important except for the obvious certainty that no *Ninia* are represented.

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[5] This name was attributed to Schlegel by Duméril, Bibron, and Duméril and by Bocourt (1883: 551) but both times without reference to a type description published by Schlegel. As far as we can ascertain, no such description by Schlegel appeared either before or after 1854. Apparently *Streptophorus Lansbergi* is a manuscript name that Duméril, Bibron, and Duméril got from Schlegel along with the Leyden Museum specimen that they mention. Since there is no indication that anyone but the three French herpetologists was responsible for the actual type description, the name must be attributed to them.

Suppression of *Coluber atratus* leaves us a choice of two names,[6] of which *Streptophorus lansbergi* Duméril, Bibron, and Duméril (1854: 518-9) is preferable over *S. drozii* Duméril, Bibron, and Duméril (*loc. cit.*) because the latter has an erroneous type locality. Our choice as first revisers is *Streptophorus lansbergi.*

Duméril, Bibron, and Duméril described *lansbergi* as follows (free translation from the French): *Scutellation.* This species has, as we will indicate, one more pair of supralabials [a total of eight supralabials on each side] than the streptophores of which descriptions precede [*S. sebae* and *S. drozii*]. Here, at least in the specimen that is the object of our investigation, the sixth supralabial on the right side contacts the eye, but it is easy to recognize that this is accidental, the lower postocular being entirely missing on the right.

The extra supralabial plate that this species exhibits is third in the row. It is shaped like a trapezoid rectangle, of which the apical angle is above and behind. As to the two that precede it and the five that follow it, they resemble the two first and the five last supralabials of the species named for Seba.

In the streptophore that is the subject of this article, the loreal plate is a little more elongate, but the lower postocular is, on the contrary, shorter, so that it does not extend at all under the eye.

There are 19 rows of scales along the body, eight on the tail, four gulars, 138 ventrals, and 44 caudals.

Coloration. The parietal plates, the neck, the upper lips, and the temples are pale white, shaded with brownish red. The other regions of the head are bluish black, as are the back, the sides, and the upper surface of the tail. All the lower parts of the body are uniformly white, except that the caudals are bordered with blackish pigment.

Dimensions. The head has a length double its width. The eyes are a third the interorbital distance. The trunk is nearly 39 times as long as wide; the tail is only barely a sixth part of the body, which altogether measures 327 mm. long. Head 12 mm., trunk 255 mm., tail 60 mm.

A specimen of this species which we have studied, belongs to the Museum of Leyden, to which it was sent from Caracas by M. Lansberg. However the Museum of Paris possesses another example (end of translation).

---

[6] The Stockholm meeting (1953) of the International Commission of Zoological Nomenclature reportedly reversed the Paris (1952) decision concerning the first reviser principle of selecting from concurrently published synonyms. If this latest proposal is ratified, a reviser again has the privilege of selecting from such names. We prefer to follow this course.

Apparently the latter cotype is MHNP No. 3446. The former cotype, on which most of the type description may have been based, has not been mentioned in recent years.

The Central American species, *maculata* and *sebae*, were placed together as a single northern subspecies of *N. atrata* (*N. lansbergi*) until Dunn (1935: 10-11) demonstrated three separate species. Parker discussed variation of *N. lansbergi* in describing the closely related *N. hudsoni*. In the absence of evidence of a subspecific relationship between *hudsoni* and *lansbergi*, reasons for subsequent use of the trinomial are not clear to us. This is one of 69 snakes treated by Dunn (1949) in his account of the relative abundance of Panamanian snakes. In addition, Taylor (1951 and 1954) gave taxonomic data for specimens from Costa Rica and Brongersma, Alemán, Marcuzzi, and Roze for Venezuela.

3. *Ninia maculata maculata* (Peters)

Pacific Banded Coffee Snake

Streptophorus maculata Peters, Mon. Akad. Wiss. Berlin, 1861 (1862), p. 924 (type locality, Costa Rica; types Z.M.B. Nos. 1872-1874.

Ninia atrata sebae (*nec* Duméril, Bibron, and Duméril), Amaral, Mem. Inst. Butantan, vol. 4, 1930, p. 151 (in part).

Ninia maculata, Dunn, Proc. Nat. Acad. Sci., vol. 21, no. 1, 1935, p. 11 (in part; synoptic treatment); Dunn and Bailey, Bull. Mus. Compar. Zool., vol. 86, no. 1, 1939, p. 7 (localities in Panamá and Panama Canal Zone); Slevin, Proc. California Acad. Sci., ser. 4, vol. 23, no. 32, 1942, p. 468 (Boquete, province of Chiriquí, Panamá); Dunn, Copeia, 1947, no. 3, p. 157 (relative abundance on the Pacific slope of Chiriquí Volcano, western Panamá); Dunn, Ecology, vol. 30, no. 1, 1949, p. 44 (in part; general distribution and relative abundance in Panamá); Taylor, Univ. Kansas Sci. Bull., vol. 34, pt. 1, no. 1, 1951, pp. 51-53, pl. 5, figs. 1-3 (Costa Rica); Taylor, Univ. Kansas Sci. Bull., vol. 36, pt. 2, no. 11, 1954, p. 698 (Costa Rica; additional distributional and variational data).

Ninia maculata maculata, Stuart, Misc. Publ. Mus. Zool. Univ. Michigan, no. 69, 1948, p. 75 (in part; comparison with *pavimentata*).

Darien and the Panama Canal Zone, west and north at least to central Costa Rica. It occurs principally on the Pacific side of Central America but crosses the divide into Caribbean drainage in Costa Rica.

Dunn (1935) showed that *maculata* is specifically distinct from *N. lansbergi*. Slevin presented information on ecology and on variation of the Pacific Banded Coffee Snake in western Panamá. *N. m. maculata* occurs in western and central Costa Rica and *tessellata* in eastern Costa Rica. The two forms are known to meet in the extreme eastern part of the Meseta Central at Turrialba. A small series from there—K.U.M.N.H. Nos. 30935, 30936, 30945, 31910, and 31915 from several localities near Turrialba—suggest to us that intergradation occurs. For the most part, the data for these specimens (Table 1) are intermediate between those of typical populations of *maculata* and *tessellata* (Table 2); however in the degree of contrast of dorsal bands and ground color, in preserved material each specimen, instead of being intermediate, closely resembles either *maculata* (bold contrast) or *tessellata* (less contrast). We interpret this tendency toward dimorphism to be another evidence of intergradation. However with so few critical specimens and with no information on population genetics in *Ninia*, we cannot rule out the possibility that two sharply convergent but *not* intergrading forms are represented.

TABLE I

Data for Presumed Intergrade Populations (*maculata* X *tessellata*) from Central Costa Rica

Specimen number*	Sex	Ventrals	Caudals	Body bands	Coloration†
31910	♂	135	47	38	M
31915	♂	134	56	31	M
30936	♂	134	60	49	T
30935	♀	133	50	46	T
30945	♀	135	50	40	M

* K.U.M.N.H. specimens.

† Indicated as *maculata* type (M) or *tessellata* type (T), in reference to general coloration.

N. maculata maculata is distinctive in having 25 or fewer dark, contrasting transverse bands; ventrals 132 to 143 in males, 139 to 155 in females; and caudals 52 to 58 in males, 47 to 55 in females. On the basis of specimens reported in literature the following can be added to Taylor's localities: Boquete (Slevin) and Yaviza (Dunn and Bailey), both in Panamá, and Cartago, Costa Rica (Boulenger, 1893: 294).

4. *Ninia maculata tessellata* Cope [new comb.]

Caribbean Banded Coffee Snake

Ninia sebae tessellatus Cope, Journ. Acad. Nat. Sci. Philadelphia, ser. 2, vol. 8, 1875, p. 145 (type locality, Sipurio, Costa Rica; types, U.S.N.M. Nos. 32568-32569).

Streptophorus maculatus tessellatus, Bocourt, Mission Scientifique au Mexico . . . Reptiles, livr. 9, 1883, p. 550.

Streptophorus atratus (*nec* Hallowell), Günther, Biologia Centrali-Americana. Part 4. Reptilia and Amphibia, 1893, p. 101 (Irazú, Costa Rica and Chontales, Nicaragua).

Streptophorus subtessellatus Werner, Mitt. Nat. Mus. Hamburg, Jahrg. 26, 1910, p. 215 (type locality, "Carriblanco," now spelled Cariblanco, Costa Rica; type, N.M.H. No. 4185).

Ninia maculata (*nec* Peters), Dunn, Proc. Nat. Acad. Sci., vol. 21, no. 1, 1935, p. 11 (in part; synoptic treatment); Dunn, Ecology, vol. 30, no. 1, 1949, p. 44 (in part; relative abundance in Panamá).

Ninia maculata maculata (*nec* Peters), Stuart, Misc. Publ. Mus. Zool. Univ. Michigan, no. 69, 1948, p. 75 (in part).

Ninia tessellata, Taylor, Univ. Kansas Sci. Bull., vol. 34, pt. 1, no. 1, 1951, pp. 53-55, pl. 2, figs. 3-4 (Costa Rica; resurrection); Taylor, Univ. Kansas Sci. Bull., vol. 36, pt. 2, no. 11, 1954, pp. 698-699 (additional distributional and variational data for Costa Rica).

Caribbean-drained portions of Costa Rica, of southern Nicaragua, and probably of Panamá.

Taylor recently separated *tessellata* from *maculata,* with which it had long been synonymized. In contrast to *N. maculata maculata,* it has 50 or more dark transverse bands, less contrast in the dorsal coloration; ventrals 125 to 130 in males, 129 to 134 in females; and caudals 53 to 60 in males, 44 to 51 in females. On the basis of the scale characters, the specimens reported from Chontales, southeastern Nicaragua by Günther belong to this subspecies.

5. *Ninia maculata pavimentata* (Bocourt)

Northern Banded Coffee Snake

Streptophorus maculatus pavimentatus Bocourt, Mission Scientifique au Mexico . . . Reptiles, livr. 9, 1883, pp. 549-550, pl. 32, figs. 8a-d, pl. 33, fig. 2 (type locality, "Haute Vera Paz" = Alta Verapaz, Guatemala; type M.H.N.P. Nos. 1152 a-d, further data below).

Ninia maculata pavimentata, Stuart, Misc. Publ. Mus. Zool. Univ. Michigan, no. 69, 1948, p. 75. (department of Alta Verapaz, Guatemala; rediscovery); Stuart, Contrib. Lab. Vert. Zool. Univ. Michigan, no. 45, 1950, p. 24 (department of Alta Verapaz, Guatemala, ecology).

One definite locality: Finca Chichén, altitude 1410 meters, department of Alta Verapaz, Guatemala.

The four cotypes include three females and a male, with ventrals 148, 144, 144, and 143 and subcaudals 72, 68, 70, and 76, respectively and in the order in which the museum numbers appear above.

Dunn (1935: 12) could not associate the name with any specimens available to him. Stuart (1948) revived the subspecies on rediscovery of it on the Caribbean side of the continental divide in Guatemala. A considerably greater number of ventrals and caudals distinguishes *pavimentata* from both *tessellata* and *maculata;* and the colorations of all three are distinctive. However the tentative arrangement of *pavimentata* as a subspecies of *N. maculata,* proposed in the type description of *pavimentata,* must await final confirmation in collections from the 500 mile gap between their known ranges.

6. *Ninia psephota* (Cope)

Red-bellied Coffee Snake

Catastoma psephotum Cope, Journ. Acad. Nat. Sci. Philadelphia, ser. 2, vol. 8, 1875, p. 145 (type locality, Pico Blanco, altitude of 5,000 to 7,000 feet, eastern Costa Rica; type, U.S.N.M. No. 61971).

Ninia psephota, Dunn, Amer. Mus. Nov., no. 314, 1828, p. 2 (generic allocation); Amaral, Mem. Inst. Butantan, vol. 4, 1930, p. 151 (distribution); Dunn, Proc. Nat. Acad. Sci., vol. 21, 1935, p. 12 (in part; synoptic treatment); Slevin, Proc. California Acad. Sci., ser. 4, vol. 23, no. 32, 1942, p. 469 (Boquete, province of Chiriquí, Panamá; variation); Dunn, Copeia, 1947, no. 3, p. 153 (relative abundance in province of Chiriquí, Panamá); Taylor, Univ. Kansas Sci. Bull., vol. 34, pt. 1, no. 1, 1951, p. 55 (Costa Rica).

Subtropical zone, above an altitude of approximately 4,000 feet, on Volcán de Chiriquí in western Panamá and on adjacent mountains (the Cordillera de Talamanca) of eastern Costa Rica.

In western Panamá where *psephota* was first found by Slevin, it is the third most abundant snake in the subtropical zone.

7. *Ninia oxynota* (Werner)

Costa Rica Coffee Snake

Streptophorus oxynotus Werner, Mitt. Naturh. Mus. Hamburg, Jahrg. 26, 1910, p. 216 (type locality, "Carriblanco" now Cariblanco, Costa Rica; type, N.M.H. No. 4184).

Ninia oxynota, Taylor, Univ. Kansas Sci. Bull., vol. 34, pt. 1, no. 1, 1951, p. 56 (Costa Rica; resurrection; variation); Taylor, Univ. Kansas Sci. Bull., vol. 36, pt. 2, no. 11, 1954, p. 699 (Costa Rica; variation and distribution).

Subtropical zone, above an altitude of approximately 4,000 feet, in the Cordillera Central of central Costa Rica.

In reviving this form, Taylor pointed out its relationship to *psephota;* however he considers them specifically distinct.

8. *Ninia sebae sebae* (Duméril, Bibron, and Duméril)

Common Red-backed Coffee Snake

Streptophorus Sebae Duméril, Bibron, and Duméril, Erpétologie générale . . ., vol. 7, 1854, p. 515 (type locality, Mexico, subsequently restricted to Veracruz, state of Veracruz; type, M.H.N.P. No. 3778; ♂ 134V + 60C).

Elapoidis fasciatus Hallowell, Proc. Acad. Nat. Sci. Philadelphia, 1855, p. 35, pl. 4 (type locality, Honduras; type, A.N.S.P. No. 3409).

Streptophorus sebae collaris Jan, Arch. Zool., vol. 2, no. 2, 1862, p. 27 (type locality, Mexico); Bocourt, Mission Scientifique au Mexico . . . Reptiles, livr. 9, 1883, p. 547.

Streptophorus sebae var. *dorsalis* Bocourt, Mission Scientifique au Mexico . . . Reptiles, livr. 9, 1883, p. 547 (type locality, Belize, British Honduras; type, M.H.N.P. No. 1171, ♂ 132V + 61C).

Streptophorus sebae var. *punctulatus* Bocourt, Mission Scientifique au Mexico . . . Reptiles, livr. 9, 1883, p. 547 (type locality, Guatemala; types, M.H.N.P. Nos. 95-95 and 95-96, ♀ 141V + 52C and ♂ ?V + 59C, respectively).

Ninia atrata sebae, Amaral, Mem. Inst. Butantan, vol. 4, 1930, p. 151 (in part).

Ninia sebae, Dunn, Proc. Nat. Acad. Sci., vol. 21, no. 1, 1935, p. 11 (synoptic treatment); Davis, Zool. Ser. Field Mus. Nat. Hist., vol. 20, no. 22, 1936, p. 273 (secondary sexual characters); Gaige, Hartweg, and Stuart, Occas. Papers Mus. Zool. Univ. Michigan, no. 357, p. 15 (Nicaragua; localities and variation); Slevin, Proc. California Acad. Sci., ser. 4, vol. 23, no. 26, 1939, p. 308 (Finca El Cipres, on Volcán Zunil, department of Suchitepequez, Guatemala); Stuart, Misc. Publ. Mus. Zool. Univ. Michigan, no. 29, p. 51 (La Libertad, department of Petén, Guatemala; variation).

Ninia sebae sebae, Schmidt and Andrews, Zool. Ser. Field Mus. Nat. Hist., vol. 20, no. 18, 1936, p. 169 (general distribution; variation in Veracruz and British Honduras; type locality restricted to the state of Veracruz, Mexico); Taylor, Univ. Kansas Sci. Bull., vol. 26, no. 14, 1940, pp. 450-451 (states of Veracruz and Puebla, Mexico; variation); Schmidt, Zool. Ser. Field Mus. Nat. Hist., vol. 22, no. 8, 1941, p. 497 (British Honduras; localities and variation); Smith, Proc. U. S. Nat. Mus., vol. 93, no. 3169, 1943, p. 456 (states of Veracruz and Chiapas, Mexico); Stuart, Occas. Papers Mus. Zool. Univ. Michigan, no. 471, 1943, p. 24 (Sierra de los Cuchumatanes, Guatemala); Smith, Journ. Washington Acad. Sci., vol. 34, no. 5, pp. 154-156 (state of Tabasco, Mexico; variation); Smith and Taylor, Bull. U. S. Nat. Mus., no. 187, 1945, p. 100 (Mexico; distribution); Smith and Taylor, Univ. Kansas Sci. Bull., vol. 33, pt. 2, no. 8, 1950, p. 351 (type locality further restricted to Veracruz, state of Veracruz, Mexico); Stuart, Misc. Publ. Mus. Zool. Univ. Michigan, no. 69, 1948, p. 75 (department of Alta Verapaz, Guatemala; habitat; breeding; variation); Stuart, Proc. Biol. Soc. Washington, vol. 62, p. 165 (Finca La Paz, department of San Marcos, Guatemala); Stuart, Contrib. Lab. Vert. Zool. Univ. Michigan, no. 45, 1950, p. 18 (department of Alta Verapaz, Guatemala; ecology; zoogeography); Shannon, Proc. U. S. Nat. Mus., vol. 101, no. 3284, 1951, p. 48 (San Lucas Camotlán, state of Oaxaca, Mexico; habitat; variation); Taylor, Univ. Kansas Sci. Bull., vol. 34, pt. 1, no. 1, 1951, p. 48 (Costa Rica); Mertens, Abh. Senck. Nat. Ges., no. 487, 1952, p. 68, pl. 14, fig. 81 (El Salvador; distribution and variation); Taylor, Univ. Kansas Sci. Bull., vol. 36, pt. 2, no. 11, 1954, pp. 695-696 (La Lola, Limón Province, Costa Rica; variation).

The states of Oaxaca and Veracruz, Mexico, south at least to Costa Rica and possibly to the province of Chiriquí, western Panamá.

When Dunn (1935) showed that *sebae* is specifically distinct from *N. lansbergi*, he recorded the former species at Boquete, province of Chiriquí, Panamá; but in a later paper (1947), which purports to be a detailed consideration of the ophiofauna of the vicinity of Boquete, he does not mention *sebae*. Apparently there is either a misidentification in the former paper or an oversight in the latter paper.

Schmidt and Andrews gave an account of the variation of this form in segregating the Yucatecan subspecies, *morleyi*. Subsequently extensive information has been contributed by Mertens, Schmidt, Smith, Stuart, and Taylor on specimens collected in El Salvador, British Honduras, Mexico, Guatemala, and Costa Rica, respectively.

9. *Ninia sebae morleyi* Schmidt and Andrews

Yucatán Red-backed Coffee Snake

Ninia sebae (*nec* Duméril, Bibron, and Duméril), Gaige, Carnegie Inst. Washington, Publ. No. 457, 1936, p. 298 (States of Yucatán and Campeche, Mexico).

Ninia sebae morleyi Schmidt and Andrews, Zool. Ser. Field Mus. Nat. Hist., vol. 20, no. 18, 1936, p. 169 (type locality, Chichén Itzá, state of Yucatán, Mexico; type, C.N.H.M. No. 20619); Andrews, Zool. Ser. Field Mus. Nat. Hist., vol. 20, no. 25, 1937, p. 357 (variation); Smith, Occas. Papers Mus. Zool. Univ. Michigan, no. 388, 1938, p. 19 (Encarnación and Pital, state of Campeche, Mexico); Taylor, Univ. Kansas Sci. Bull., vol. 26, no. 14, 1940, p. 451 (variation); Smith, Proc. U. S. Nat. Mus., vol. 93, no. 3169, 1943, p. 457 (variation); Smith and Taylor, Bull. U. S. Nat. Mus., no. 187, 1945, p. 100 (states of Yucatán and Campeche and territory of Quintana Roo).

Dryer distal part of the Yucatán Peninsula in the state of Yucatán, and in at least the northern part of the state of Campeche and of the territory of Quintana Roo.

This subspecies has been distinguished from the nominal one only by differences in number of ventrals and caudals. In the type description, eight specimens of it were compared with 30 of *sebae.* Acquisition of data for many additional specimens of both races has indicated that their variation overlaps considerably in both diagnostic features; however, taken together the two "counts" serve to adequately distinguish the peninsular populations from those of the mainland.

10. *Ninia diademata nietoi* subspec. nov.[7]

Caribbean Ring-necked Coffee Snake

Streptophorus diademata (*nec* Baird and Girard), Günther, Biologia Centrali-Americana, pt. 4, 1893, p. 102 (in part; Teapa, state of Tabasco, Mexico); Boulenger, Catalogue of the snakes in the British Museum (Nat. Hist.), vol. 1, 1893, p. 292 (in part).

Ninia diademata (*nec* Baird and Girard), Dunn, Proc. Nat. Acad. Sci., vol. 21, 1935, p. 12 (in part; synoptic treatment); Stuart, Misc. Publ. Mus. Zool. Univ. Michigan, no. 69, 1948, p. 74 (in part; variation; department of Alta Verapaz, Guatemala); Stuart, Contrib. Lab. Vert. Zool. Univ. Michigan, no. 45, 1950, p. 24 (department of Alta Verapaz, Guatemala; ecology and zoogeography).

Ninia atrata (*nec* Hallowell), Günther, Biologia Centrali-Americana, Reptilia and Batrachia, August, 1893, p. 101 (in part; Puerto Cabello, Honduras).

Ninia diademata diademata (*nec* Baird and Girard), Smith, Copeia, 1942, no. 3, pp. 152-154 (in part; variation and geographical distribution); Smith, Proc. U. S. Nat. Mus., vol. 93, no. 3169, 1943, p. 455 (in part; Piedras Negras, department of Petén, Guatemala).

Diagnosis. Very similar in color to *N. d. diademata* and *N. d. plorator*, from which it is apparently distinguishable only by number of ventrals and caudals (Table 1 and Figure 2). Ventrals 127 to 131 in males, 131 to 137 in females, thus very similar to *plorator* and exceeding *diademata.* Caudals 91 to 106 in males, 91 to 98 in females, thus averaging more than either subspecies and overlapping both, *diademata* extensively, *plorator* very slightly.

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[7] This form is named for Dr. Vicente X. Nieto who, as head of the Centro de Higiene, Seccion de Enfermedades Tropicales at Boca del Río, Veracruz, Mexico, extended many kindnesses to the junior author. Through his assistance, Doctor Nieto was instrumental in the discovery of the new snake.

Type specimens. Holotype, U.I.M.N.H. No. 2851, male from San Andrés Tuxtla, state of Veracruz, Mexico. Paratypes: M.C.Z. Nos. 20202, 38704, and 38705 from Subirana, Portillo Grande, and Tela, respectively, all in Honduras, and 24937 from Uaxactun, department of Petén, Guatemala; U.S.N.M. Nos. 35858 and 109807 from Finca Acleta, department of Alta Verapaz, and Piedras Negras, department of Petén, both in Guatemala; U.M.M.Z. Nos. 91122a and 91122b, both from Finca Primavera, department of Alta Verapaz, Guatemala. Data is given by Boulenger for a specimen from Teapa, state of Tabasco, Mexico.

These localities indicate a distribution from southern Veracruz to northeastern Honduras on the Atlantic side of the continental divide.

Description of holotype: Rostral half again as large as combined internasals, less than one third of former plate visible from above, most of remaining two thirds involved in semicircular concavity directed anteroventrad; internasals one fourth to one fifth size of prefrontals; latter enter orbits; frontal about as broad as long, subequal in length to its distance from rostral and from posterior end of parietals; supraocular rectangular, over four fifths as long as greatest length of orbit and about half as wide; nasal completely divided, almost twice as large as loreal; latter rectangular, about one and three-fourths times as long as high, entering eye; two postoculars, the upper about three times size of lower; temporals 1-2 on right, the anterior the largest, 2-2 on left, the upper anterior very small, the lower anterior larger than either posterior one; supralabials 6-6, only the third entering the orbit, second and third in contact with loreal, progressively increasing in size from first to fifth, the fifth and sixth subequal, former somewhat longer, latter somewhat higher; six infralabials, the fourth largest, others progressively decreasing in size toward either end, except first which is larger than second or third, first four in contact with chinshields; latter in two pairs, anterior almost three times size of posterior; spiny tubercles present on chin, particularly prominent and profuse on first three infralabials and on anterior chinshields.

Dorsal scales in 19 rows throughout; ventrals 131, the first in contact with posterior chinshields; two scales separate first two ventrals from lower row of dorsals on each side; anal entire; caudals divided, 102 in number; tail broken, the posterior third hanging loosely.

The following notes describe the coloration of the holotype after preservation for one year. Dorsal and lateral surfaces of head black except for last supralabial, all but upper edge of other supralabials, posterior part of anterior temporal, and entire lower secondary temporal; these areas yellow and continuous with yellow collar around neck; collar widest on sides, there covering first to third tier of scales behind parietal, and interrupted middorsally by a narrow black isthmus connecting black crown to upper body color; on each side of neck an irregular reticulum extends forward along scale sutures into the yellow collar at level of second scale above ventrals from position of fourth to that of first ventral. Body and tail black above; in center of each scale an elongate, diffuse, light area; these

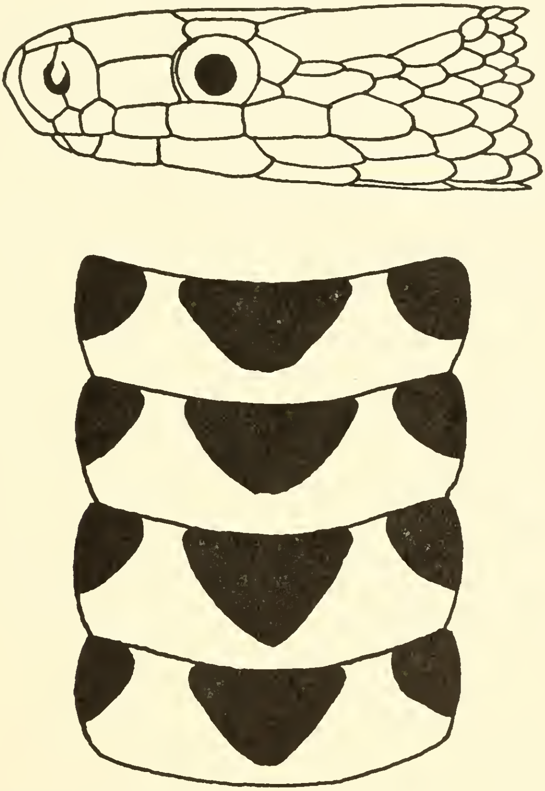

FIG. 1. *Ninia diademata nietoi* subsp. nov. Holotype. U.I.M.N.H. No. 2851; San Andrés Tuxtla, state of Veracruz, Mexico.

light spots decrease in size dorsally and posteriorly; behind collar those on lower scale row three fourths area of scale, on middorsal scale row less than one half area of scale; in front of anus lower spots about one half area of scale, upper spots less than one fourth area of scale; general effect of body color reminiscent of *Drymobius margaritiferus.* Ventral surface yellowish white with bluish undercast; mental, first infralabials, first chinshields, and edges of adjacent infralabials black; a very regular mid-ventral series of black spots from second ventral to near end of tail, each ventral having a spot extending nearly its length; anterior spots about twice as long as wide, increasing in width posteriorly to a point about three quarters distance to tail, where spots considerably over twice as wide as long, from there to anus reducing in width; last mid-ventral spot slightly longer than wide; anal spot reverts to oval, wider than long; series continues on tail as stripe, at first lobed (like on belly), then narrower, zigzagging along median subcaudal sutures, and disappearing about ten scales short of tail tip.

11. *Ninia diademata labiosa* (Bocourt) [8]

Pacific Ring-necked Coffee Snake

Streptophorus labiosus Bocourt, Mission Scientifique au Mexico . . . Reptiles, livr. 9, 1883, pp. 550-551, pl. 32, figs. 6a-f (type locality, Guatemala here restricted to Yepocapa, dept. Chimaltenango; type, M.H.N.P. No. 5944, ♂ 145 V + 100 C).

Ninia diademata labiosa, Amaral, Mem. Inst. Butantan, vol. 4, 1930, p. 151 (unsupported resurrection).

Ninia diademata diademata (*nec* Baird and Girard), Smith, Proc. U. S. Nat. Mus., vol. 93, no. 3169, 1943, p. 456 (in part; Totonatepec, state of Oaxaca, Mexico); Smith and Taylor, Bull. U. S. Nat. Mus., no. 187, 1945, p. 99 (in part; state of Oaxaca, Mexico); Livezey and Pakham, Herpetologica, vol. 8, pt. 4, 1953, p. 176 (data for one specimen from La Reforma, department of San Marcos, Guatemala).

Diagnosis. Subspecifically distinctive in the reduction in size of the dark ventral spots (Figure 2) and in the complement of ventrals and caudals. The first feature is unique to *labiosa.* In the second respect, *labiosa* is very similar to *diademata* (the former subspecies averages slightly lower in ventrals and slightly higher in caudals than the latter) and is well distinguished from the remaining subspecies (in ventrals exceeding *plorator* but very similar to *nietoi*).

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[8] Not recognizing the proper applicability of the name *labiosa* to this subspecies, we originally intended to describe it as new. When he called our attention to it, Dr. L. C. Stuart requested that we name it for his good friend, Dr. Colvin Gibson who, as a member of the Onchocerciasis Project of the Pan-American Sanitary Bureau in Guatemala, devoted much energy and time to the assembling of a herpetological collection from the Yepocapa region where this snake was rediscovered. Needless to say, we are disappointed that our indebtedness to Drs. Gibson and Stuart can be expressed only by this intangible word of thanks.

Distribution and material examined. Pacific slope from the Isthmus of Tehuantepec, southeast to south central Guatemala.

All names in small capital letters are departments in Guatemala except Oaxaca and Chiapas, which are states in Mexico. The holotype, M.H.N.P. No. 5944 came from "Guatemala." Definite localities are as follows.

Mexico. CHIAPAS: Soconusco region (U.I.M.N.H. No. 34330); OAXACA: Totonatepec (U.S.N.M. Nos. 20834, 46536).[9] Guatemala. CHIMALTENANGO: Finca Recreo, altitude 1,350 meters, 7 kilometers (straight line) south of Yepocapa (U.M.M.Z. No. 102636); Yepocapa, 1 kilometer south of, altitude 1,300 meters (U.M.M.Z. No. 102638). SAN MARCOS: Finca La Paz, 1,100 meters (U.M.M.Z. Nos. 106687, 106689); same, altitude 1,185 meters (U.M.M.Z. No. 102637); same, altitude 1,240 meters (U.M.M.Z. No. 107016); same, altitude 1,300 meters (U.M.M.Z. No. 106690); La Reforma (U.N.D. No. ——). SOLOLA: Finca Santa Emilia, near Pochuta (M.C.Z. No. 31945). SUCHITEPEQUEZ: Finca Cipres, 9 miles north of Mazatenango (M.C.Z. No. 22103).

Type description. The following is a free translation of Bocourt's (above cited) type description, which was based on a single specimen (M.H.N.P. No. 5944) presented by the Economic Society of Guatemala.

Body slender and elongate. Nine supracephalic plates, of which the parietals, which are notched behind, carry traces of keels. Nostril opens in the midst of two large plates. Eye large, projecting, and surrounded by six scales, of which the upper postocular is closely fused to the supraocular. Seven infralabials; the first four in contact with the chinshields. Two chinshields, followed by 143 gastrosteges. Tail rather long, furnished beneath with 100 double urosteges.

Total length of the only individual, 313 mm.; length, snout to vent, 211; length of tail, 102.

The upper parts of the body are of a slate-colored brown, without any black spots; on the nuchal region one sees an orange-yellow collar, of which the right side is separated from the left side by a mid-cervical brown line, thus joining the dark color of the head to that of the body. All the lower parts, also the lips and the temples, are shaded with yellow. The gastrosteges beyond a short distance of the head are marked by a brown dot in their median part (end of translation).

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[9] These appear to be intergrades, with *N. d. diademata*.

On the plate acompanying the above description, the origin of the type is indicated simply as Guatemala. Figure 6b and 6c of this plate shows a series of small mid-ventral dots. Figure 6a shows the loreal to be 1.3 times as long as high.

Discussion. As is often the case when one resurrects old names, an element of doubt accompanies our association of the name *labiosa* with the Pacific Ring-necked Coffee Snake. In almost all respects the holotype of *labiosa* falls within the range of variation of available series from the Pacific slope of Guatemala. However the type specimen has one more plate in each series of labials than any other example of the subspecies. Every indication suggests this divergence to be an individual aberration without racial or geographic significance.

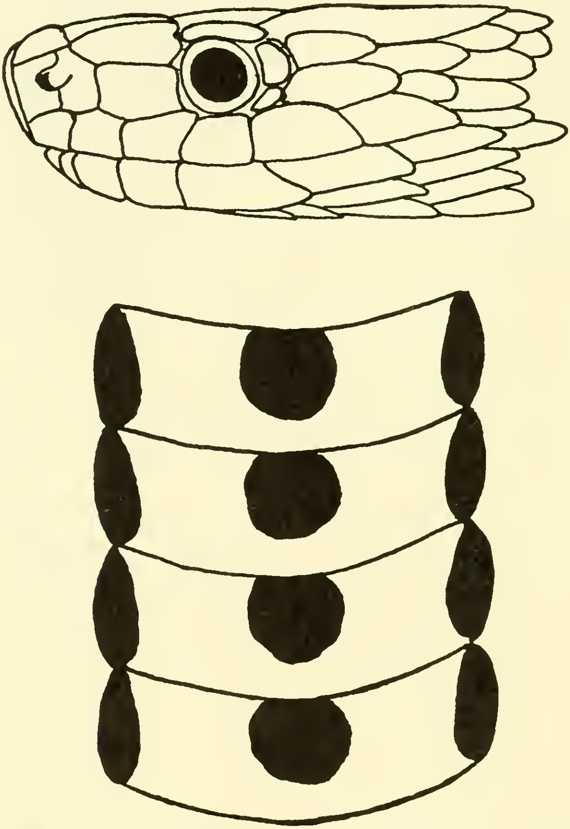

FIG. 2. *Ninia diademata labiosa* (Bocourt). M.C.Z. No. 31945; Finca Santa Emilia, near Pochutla, department of Sololá, Guatemala.

12. *Ninia diademata diademata* Baird and Girard

Veracruz Ring-necked Coffee Snake

Ninia diademata Baird and Girard, Catalogue of North American reptiles in the Museum of the Smithsonian Institution, pt. 1, 1853, p. 49 (type locality, Orizaba, state of Veracruz, Mexico; type, U.S.N.M. No. 12122); Dunn, Proc. Nat. Acad. Sci., vol. 21, no. 1, 1935, p. 12 (in part; synoptic treatment); Taylor and Smith, Univ. Kansas Sci. Bull., vol. 25, no. 13, 1938, p. 252 (state of Veracruz, Mexico); Stuart, Misc. Publ. Mus. Zool. Univ. Michigan, no. 69, 1948, p. 74 (in part).

Streptophorus bifasciatus Duméril, Bibron, and Duméril, Erpétologie générale . . ., vol. 7, 1854, p. 520 (type locality, Mexico; type M.H.N.P. No. 5939, ♀ 152V 85 + C; Bocourt, Mission Scientifique au Mexico . . . Reptiles, livr. 9, 1883, pp. 545-546, pl. 32, figs. 10a-b.

Ninia diademata diademata, Amaral, Mem. Inst. Butantan, vol. 4, 1930, p. 151 (distribution); Smith, Copeia, 1942, no. 3, pp. 152-154 (in part; state of Veracruz, Mexico); Smith and Taylor, Bull. U. S. Nat. Mus., no. 187, 1945, p. 99 (in part; Mexico); Shannon and Smith, Trans. Kansas Acad. Sci., vol. 52, no. 4, 1949, p. 500 (state of Puebla, Mexico).

Diagnosis. Very similar in color to *N. d. nietoi* and *N. d. plorator.* It has fewer subcaudals than either and an intermediate number of ventrals.

Distribution and material examined. Foothills and mountains of Caribbean-drained areas from central Veracruz, south almost to Comitán, state of Chiapas, Mexico.

The names in small capital letters in the following localities are all states in Mexico.

CHIAPAS: Las Rosas, 13 miles east of, U.I.M.N.H. No. 6303; Pichucalco, 15 miles south of, U.I.M.N.H. No. 6304-9; Rancho Nuevo, 18 miles north of Teopisca, U.I.M.N.H. No. 6302. OAXACA: Indefinite locality (Boulenger, 1893: 292); Tehuantepec, probably the general region of the isthmus, U.S.N.M. No. 30342. PUEBLA: Teziutlán, 6-7 miles northeast of, U.I.M.N.H. No. 3822. VERACRUZ: Ochotal, C.N.H.M. No. 2509; Córdoba, 10 miles south of, U.I.M.N.H. No. 18660; Cuautlapan, U.I.M.N.H. No. 18661-73, U.S.N.M. No. 109811-22; Huatusco (Peters, 1861: 460); Jalapa, M.C.Z. No. 16112-21; Mirador (Smith, 1943: 456); Orizaba (Smith, 1943: 455); Tequeyutepec, U.S.N.M. No. 109808-10; Veracruz, hills west of (Smith, 1943: 456).

Discussion. In beginning partition of *diademata* into subspecies, Smith (1942, 1943) summarized available information on variation of the species. Considerable modification of previous authors' notions of the variation and distribution of the nominal subspecies accompanies our segregation of two more subspecies. In addition, its range has been extended from the states of Veracruz and adjacent Oaxaca, where typical *diademata* has long been known, to eastern Puebla by Shannon and Smith and to central Chiapas, as first reported here.

13. *Ninia diademata plorator* Smith

Hidalgo Ring-necked Coffee Snake

Ninia diademata plorator Smith, Copeia, 1942, no. 3, pp. 152-154 (type locality, Durango, state of Hidalgo, Mexico); Smith and Taylor, Bull. U. S. Nat. Mus., no. 187, 1945, p. 100 (distribution); Taylor, Univ. Kansas Sci. Bull., vol. 33, pt. 1, no. 2, 1949, p. 195 (Xilitla region, state of San Luis Potosí, Mexico; variation); Taylor, Univ. Kansas Sci. Bull., vol. 33, pt. 2, no. 11, 1950, p. 443 (additional specimen from San Luis Potosí).

Ninia diademata (*nec* Baird and Girard), Misc. Publ. Mus. Zool. Univ. Michigan, no. 69, 1948, p. 74 (in part; variation).

Diagnosis. Very similar in color to the two subspecies to the south of it, east of the continental divide. It has fewer caudals than either and ventrals numbering more than *diademata* but about the same as *nietoi.*

Distribution. Hidalgo and southern tip of San Luis Potosí, Mexico (three known localities mentioned below).

Discussion. The type description was based on two specimens, one, of course, from the type locality (E.H.T.-H.M.S. No. 23557), the other from Zacualtipan (A.N.S.P. No. 14757), both in the state of Hidalgo. On the basis of variation that he observed in specimens (here described as *N. d. nietoi*) from Alta Verapaz, Guatemala, Stuart (1948: 74) doubted the validity of *plorator;* however, so he states in a recent letter (October 21, 1952), subsequent evidence has convinced him of its validity. Conclusive evidence of the validity of *plorator* came from Taylor (1949: 195) in the form of data for six specimens from the vicinity of Xilitla (L.S.U. Nos. 220-225), in that part of the state of San Luis Potosí next to Hidalgo.

Variation of the Subspecies of *Ninia diademata*

Abdominals and subcaudals. The number of ventrals and caudals taken together offer valuable means of separating three of the subspecies of *N. diademata.* The fourth subspecies, *labiosa,* varies in such a way as to overlap broadly the nominal subspecies in both characters.

The variation of three of the subspecies is poorly circumscribed for these are represented by only eight to eleven specimens each. In *diademata,* the limits of variation, plotted from about 50 specimens, circumscribe distinct ovals with the longitudinal axes directed diagonally from upper right to lower left. This shape and orientation, if they are as distinct as they seem, reflect a positive correlation between number of ventrals and number of caudals.

One male each of *nietoi* and *labiosa* has ventrals more and caudals fewer than normal for the subspecies. Both specimens approach *diademata;* however no reasonable question can be raised as to the authenticity of locality data of either specimen.

Head scales and dorsals. The species almost invariably has 19 rows of dorsal scales throughout the length of the body and a complement of head scales that differs from the typical colubrid one only in lacking preoculars. Usually bordering the orbit are the loreal, prefrontal, supraocular, two postoculars, and the third and fourth supralabials. When the number of supralabials is reduced from six to five, only the third supralabials subtends the eye. In occasional specimens the upper postocular fuses with the supraocular. In *labiosa* the number of postoculars varies more than that of the other subspecies. The two postoculars and the supraocular may all fuse into one plate or one or the other postoculars may divide into two, making a total of three postoculars. In *labiosa,* five supralabials are almost as common as six, and five infralabials are more common than six. In the other subspecies both first-mentioned conditions are far rarer. Increases to seven in either labial series are uncommon in any subspecies. When there are six infralabials, the first four contact the anterior chinshields. When there are five, only the first three contact them. The last supralabial usually has a faint keel and apparently in some specimens this keel may extend onto the penultimate supralabial (see the description of *labiosa*).

In *diademata,* the loreal is characteristically about twice as long as high. In *labiosa,* it is approximately one and a half times as long as high. In the series that we examined 83 percent of *labiosa* have loreals less than 1.8 times as long as high and 84 percent of *diademata* have loreal 1.8 times as long as high, or longer. The proportions of the loreal of *nietoi* seem to present an intermediate condition.

Snout-vent length and relative tail length. To estimate maximum length, we have considered measurements for the longest third of the individuals representing each sex of each subspecies. For *nietoi,* these figures (length from snout to vent in mm.) are male, 196, female, 210; for *labiosa,* males, 264, 256 (mean 260.0), females, 267, 257 (mean 262.0); for *diademata,* males, 252, 243, 229, 222 (mean 236.5), females, 256, 248, 243, 241 (mean 247.0); for *plorata,* males, 204, 190 (mean 197.0), female, 223. The figure for the longest individual we call the actual maximum length; the mean of all the figures, the average maximum length. These statistics are based on the scanty data presented earlier and, consequently, do not purport to be actual maxima or accurate means for the designated populations.

Even so, these data suggest the general trends of size variation. An increase in snout-vent length downward (southeastward) in Central America is shown, except in *nietoi,* for which our data are probably inconclusive. A tendency for females to exceed males is shown by actual maxima and average maxima of all our samples. In *diademata,* which is represented by the most specimens, the average maximum of females exceeds by 10 mm. that of males.

Our information on relative tail length is even more sketchy; about 12 percent of specimens (six of 51 for which we have other measurements) lack the end of the tail. The ratios of tail to snout-vent length seem to parallel roughly the number of subcaudals with regard to racial and sexual differences.

Ventral coloration. Of all features of coloration that have occurred to us (see the type description of *nietoi*) only ventral coloration seems to vary significantly. In *diademata, plorator,* and *nietoi* the median ventral spots are quarter-moon-shaped. At midbody these spots exceed in width the light area that borders them on each side. Pigment often extends from the median spots along the scale sutures to join the spots to the dark color of the sides. In contrast, the mid-ventral spots of *labiosa* are circular and at midbody their diameter is usually less than one half the width of the lateral light part of the venter. Populations in the Atlantic drainage of Chiapas, Mexico, and of Alta Verapaz, Guatemala, (identified as *diademata* and *nietoi,* respectively, by their other characters) have ventral patterns that are, on an average, atypically reduced, though not to the *labiosa* extreme.

IDENTIFICATION OF THE OTHER SPECIES

Because of our meager acquaintance with several of the coffee snakes, we hesitate to attempt construction of a key for their identification. Instead we have organized available diagnostic information as a summary of scutellational differences (Table 2) and as an outline of their color patterns, which follows:

I. Black above, with a light collar
  A. Usually immaculate below . . . . *N. lansbergi, N. hudsoni.*
  B. Yellow with a median row of spots below (*N. diademata* subspecies).
    1. Midventral spots crescent-shaped, *N. d. diademata, N. d. plorator, N. d. nietoi.*
    2. Midventral spots circular . . . . *N. d. labiosa.*

II. Red above, with a black head, a yellow neck band bordered behind by black, and sometimes with black crossbars on the body; usually immaculate below . . . . *N. sebae sebae, N. s. moreleyi.*

III. Uniform black above, checkered black and red below . . . . *N. psephota.*

IV. Black or dark brown above, with numerous narrow white transverse lines; checkered black and ivory below . . . . *N. oxynota.*

V. Brown above with darker brown or black crossbands (*N. maculata* subspecies).
  A. Dark bands broad and numbering 25 or fewer; belly light with small quadrangular black spots scattered or in one or two longitudinal rows, subcaudal surface black . . . . . . *N. maculata maculata.*
  B. Dark bands narrow and numbering 50 or more; belly white or ivory checkered with black, the latter color increasing posteriorly, *N. m. tessellata* and *N. m. pavimentata.*

TABLE 2

Differences in Scutellation of the Species and Subspecies of *Ninia* *

Name of form	Labials		Ratio of length to height of loreal	Dorsal scale rows	Ventrals		Caudals	
	Supra-	Infra-			Males	Females	Males	Females
N. hudsoni	7	7	1.0–1.1	19	139–141	....	66–67	....
N. lansbergi	7	7	1.3–2.0	19	130–142	140–155	45–67	34–54
N. maculata maculata	7	7	....	19	132–139	138–144	52–63	47–55
N. maculata tessellata	7	7	....	19	125–130	129–134	53–60	44–51
N. maculata pavimentata	7	7	1.6	19	143	144–148	76	68–72
N. psephota	6	6	1.2	17	147–153	139–162	63–73	51–73
N. oxynota	6	6	10–14 (1.2)	17	152–163	160–164	70–76	65–75
N. sebae sebae	7	7	1.6–2.8 (2.2)	19	131–151	138–154	51–71	40–60
N. sebae moreleyi	7	7	....	19	137–147	143–159	44–54	38–46
N. diademata nietoi	6	6	1.5–2.1 (1.8)	19	127–131	130–137	91–106	91–98
N. diademata labiosa	5,6	5,6	1.0–1.9 (1.5)	19	132–145	138–150	93–103	82–94
N. diademata diademata	6	6	1.3–2.8 (2.1)	19	136–148	135–155	86–98	78–94
N. diademata plorator	6	6	1.4,1.5	19	123–133	129–137	83–93	73–81

* Ranges of variation are indicated by dashes between numbers; means, by parentheses. Variations beyond the values given here, especially in number of labials and of dorsal scale rows are not uncommon. For information in this regard see the characterization of the genus and the account of variation in *Ninia diademata*.

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Further Studies on the Serpents of Costa Rica

By

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ABSTRACT: Additional collections of reptiles from Costa Rica made in 1951 and 1952 include some 90 species or subspecies of snakes, bringing the known serpent fauna of the country to 151 forms. In this work the following new species or subspecies are described: *Geophis bakeri, Geophis zeledoni, Geophis acutirostris, Ninia cerroensis, Dryadophis sanguiventris, Pliocercus arubricus, Rhadinaea altamontanus, Rhadinaea decipiens rubricollis, Tantilla costaricensis, Dipsas tenuissima, Bothrops schlegelii supraciliaris.*

Certain species are included that did not appear in Taylor's "A Review of the Serpents of Costa Rica," 1952. These are *Loxocemus bicolor* Cope, *Trimetopon sleveni* Dunn, *Leptophis nebulosus* Oliver, *Leptophis aeruginosus* Cope, *Leptophis richardi praestans* Cope, *Dendrophidion vinitor* Smith.

INTRODUCTION

My study of the herpetological faunas of Costa Rica, begun in 1947, has been continued to date, and has involved three Costa Rican expeditions. The first, undertaken at the request of the Rector of the National University of Costa Rica, extended from June 21 to September 7, 1947. A few localities were visited and a collection, consisting of many hundreds of specimens, was obtained. The second expedition extended from June 26 to September 14, 1951. The third expedition began work in Costa Rica June 6, 1952, and kept in the field until September 14 of the same year. Using as a basis the materials obtained by myself and Richard Clark Taylor in 1947, I prepared a brief Review of the Snakes of Costa Rica which appeared October 1, 1951. In this work short descriptions of the species taken, together with descriptions or synopses of other species presumed to occur within the confines of Costa Rica, were given. Twenty-four species were illustrated.

In the collections of 1951 and 1952 there are some 90 species of snakes represented. With this material available it has been possible to modify certain ideas that I held regarding several forms; to extend the known distribution of several species, and the range of variation in others; to discover errors in statement in previous works, including my own; and to report certain forms regarded as new. In consequence I am presenting this added information here in the form of a supplement to my preceding work.

COLLECTING LOCALITIES

Among the localities visited were the following:

1. LOS DIAMANTES. An experimental rubber plantation about 2½ kilometers south of Guápiles, elevation 250 m.
2. La Lola. Experimental cacao plantation in the eastern lowlands.
3. Limón. Seaport on the Caribbean coast. Collecting was done within a radius of about three to four kilometers from the city. One trip was made on the railway to Mountain Cow Creek, southwest of Limón, in the neighboring hills.
4. Bataan. The abaca plantation of the United Fruit Company in the eastern lowlands.
5. Tunnel Camp. A point on the railway near Lake Bonilla, a small natural lake, about 10 km. east of Peralta, and at a somewhat lower elevation.
6. Turrialba and the nearby farm of the Inter-American Institute of Agriculture; elevation 624 m.
7. Santa Cruz. Village on the south slopes of Volcán Turrialba, elevation about 1,540 m. Collecting was done within a two or three kilometer radius from the town.
8. Cervantes. A village on the highway, between Turrialba and Cartago, about 11 km. east of Cartago. The region has much lava, some exposed at the surface. Elevation about 1,215-1,400 m. in the area where collections were made.
9. Cot. A village on the slopes of Volcán Irazú about 7 km. from Cartago. The elevation is about 1,580 m.
10. Curridabat. Town about 6.5 km. east of San José.
11. Escazú. Town about 6.5 km. southwest of San José on the mountain slopes. Elevation somewhat higher than San José.
12. Esparta. A small town in Puntarenas Province about 10 km. from the Golfo de Nicoya; probably not over 215 m. elevation.
13. El General or El General de Térraba. Elevation of about 625 m., San José Province, Pacific drainage.

14. Moravia (de Chirripo). Large finca. Most of the collecting was done within a two to five km. radius of the central village, at elevations of approx. 615 to 915 m.
15. Pacuare. A point where the auto road crosses the Río Pacuare, between Turrialba and Moravia de Chirripo, elevation estimated at 615 m.
16. Palmar. A village and site of United Fruit Company installations about 15 km. from the mouth of the Río Diquis (Río Grande de Térraba) near the pass in the Cordillera Brunquena. Collecting was done along the river, and in the low mountains north of the river.
17. Las Esquinas. A settlement and forest preserve of the United Fruit Company not far from the Río Esquinas between Palmar and Golfito on the railway. The rainfall here is extremely heavy.
18. Volcán Poás. A volcano still showing some activity; elevation 2,780 meters. Collecting done on southern, eastern, and northeastern slopes at various elevations.
19. San Isidro del General (sometimes written San Isidro el General). A town on the west slope of the Sierra Talamanca on the Pan-American Highway; elevation 715 m.
20. Sarchi. A small village on the Pan-American Highway between Grecia and Naranjo. Collecting was done a few kilometers east on the highway along a small stream.
21. Tenorio (de Las Cañas). Cattle ranch of the United Fruit Company in Guanacaste, from about 215 m. in the western part, up to 550 m. elevation in the east. The central installations and air field are at about 400 m.
22. Las Flores. A tiny settlement northeast of Tenorio on the ranch; elevation 475 m.; also Tenorito, 550 m.
23. Hotel Maribella. A settlement and hotel at the definitive mouth of the Río Barranca, on the west coast, at sea level.
24. Zarcero. A town north of Naranjo.
25. Villa Quesada. About 13 km. north of Naranjo and Zarcero.
26. Cariblanco. In northeastern lowlands, almost directly north of San José, at the base of the northern slope of Volcán Poás. Approximately 460 m. (?) elevation, a place with heavy rainfall.
27. Cinchona. Formerly American Cinchona Plantation or Isla Bonita, 1,520-1,675 m. elevation. Now a school.

28. Isla Bonita. The eastern part of the former American Cinchona Plantation, now a large finca being prepared for a cafetal (1952).
29. Alejuela. City, altitude about 950 m.
30. Atirro. Village on Río Reventazón, about 6.5 km. from Turrialba, of nearly the same elevation as preceding.
31. Volcán Barba. An extinct volcano lying north of the city of San José with an elevation of 2,929 m. Collections were made chiefly on the southern and western slopes at an elevation of from 1,000-2,000 m.
32. Barranca. Puntarenas Province. A small village about 10 km. from the mouth of the Río Barranca. Elevation about 75 m.
33. Puntarenas. Puntarenas Province. Situated at the end of an extremely narrow peninsula extending into the Golfo de Nicoya, at sea level.
34. La Carpintera. Mountain, somewhat between Cartago and San José, south of Tres Rios, reaching an elevation of approximately 1,825 m., the terminus of the Candalaria Mountains.
35. Cartago. On the Meseta Central. The second largest city in Costa Rica.
36. Costa Rican National Forest. A forest preserve on the Pan-American Highway south of Cartago above Empalme at an elevation of approximately 2,280 m.
37. Dominical Road. This runs from San Isidro del General to Dominical on the Pacific coast. Its direction is generally west-southwest. Localities are indicated in distances from San Isidro. At some points it probably reaches an elevation 600 m. or higher.
38. Golfito. United Fruit Company installation on Golfo Dulce, at sea level. A region of heavy rainfall.
39. Millville. Pan-American Highway installation on the Pacific slope of the Cerro de la Muerte at an elevation of 2,862 m. Collecting was done at the summit of the Cerro de la Muerte (3,300 m.), and at approximately 350 m. above and below Millville.
40. Boquete Camp. On west slope of Cerro de la Muerte at about 2,000 m.

CHECKLIST OF COSTA RICAN SNAKES

The following species are now included in the list of Costa Rican snakes.

- Anomalepis Jan
  - *dentatus* Taylor
- Liotyphlops Peters
  - *albirostris* (Peters)
- Helminthophis Peters
  - *frontalis* (Peters)
- Leptotyphlops Fitzinger
  - *albifrons* (Wagler)
- Loxocemus
  - [* *bicolor* Cope]
- Boa Linnaeus
  - *annulata* (Cope)
- Constrictor Laurenti
  - * *constrictor imperator* (Daudin)
- Epicrates Wagler
  - *cenchria maurus* Gray
- Nothopsis Cope
  - * *torresi* Taylor
- Scaphiodontophis Taylor and Smith
  - * *venustissimus* (Günther)
- Thamnophis Fitzinger
  - *sirtalis chalceus* (Cope)
- Geophis Wagler
  - [* *rhodogaster* (Cope)]
  - * *godmani* Boulenger
  - * *hoffmanni* (Peters)
  - * *dolichocephalus* (Cope)
  - * *moestus* (Günther)
  - * *brachycephalus* (Cope)
  - * *bakeri* sp. nov.
  - * *acutirostris* sp. nov.
  - * *zeledoni* sp. nov.
- Ninia Baird and Girard
  - * *sebae sebae* (Duméril, Bibron, and Duméril)
  - * *atrata* (Hallowell)
  - * *maculata* (Peters)
  - * *tessellata* Cope
  - *psephota* (Cope)
  - * *oxynota* (Werner)
  - * *cerroensis* sp. nov.
- Sibon Fitzinger
  - * *nebulatus* (Linnaeus)
- Tretanorhinus Duméril, Bibron, and Duméril
  - *nigroluteus nigroluteus* Cope

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* Indicates species discussed in this paper. Brackets indicate doubtful records.

Xenodon Boie
    * *bertholdi* Jan
    * *colubrinus* Günther
Enulius
    flavitorques (Cope)
    * *sclateri* (Boulenger)
Helicops Wagler
    wettsteini Amaral
Hydromorphus Peters
    * *concolor* Peters
Trimetopon Cope
    * *pliolepis* Cope
    viquezi Dunn
    simile Dunn
    * *sleveni* Dunn
    * *gracile* (Günther)
Hypsiglena Cope
    * *torquata torquata* (Günther)
Amastridium
    * *veliferum* Cope
Spilotes Wagler
    * *pullatus pullatus* (Linnaeus)
    pullatus mexicanus (Laurenti)
Leptophis Bell
    * *mexicanus mexicanus* Duméril, Bibron, and Duméril
    depressirostris (Cope)
    * *nebulosus* Oliver
    * *ahaetulla occidentalis* (Günther)
    * *ahaetulla praestans* (Cope)
    * *aeruginosus* Cope
Dryadophis Stuart
    * *melanolomus alternatus* (Bocourt)
    * *sanguiventris* sp. nov.
Drymobius Fitzinger
    * *margaritiferus margaritiferus* (Schlegel)
    * *rhombifer* (Günther)
    * *chloroticus* (Cope)
    * *melanotropis* Cope
Dendrophidion Fitzinger
    paucicarinatus (Cope)
    * *percarinatus* (Cope)
    * *vinitor* Smith
Pseustes Fitzinger
    * *poecilonotus chrysobronchus* (Cope)
    * *shropshirei* (Barbour and Amaral)
Chironius Fitzinger
    carinatus (Linnaeus)
    * *grandisquamis* (Peters)
    * *melas* (Cope)

- Elaphe Fitzinger
  - *triaspis* Cope
  - *flavirufa flavirufa* (Cope)
- Drymarchon Fitzinger
  - * *corais melanurus* (Duméril, Bibron, and Duméril)
- Masticophis Baird and Girard
  - *mentovarius* (Duméril, Bibron, and Duméril)
- Leptodrymus Amaral
  - *pulcherrimus* (Cope)
- Leimadophis Fitzinger
  - * *taeniurus juvenilis* Dunn
- Lampropeltis Fitzinger
  - † *doliata micropholis* Cope
  - *doliata polyzona* Cope
  - *doliata gaigae* Dunn
- Pliocercus Cope
  - *dimidiatus* Cope
  - *annellatus* Taylor
  - * *arubricus* sp. nov.
- Liophis Wagler
  - *cobella* (Linnaeus)
- Rhadinaea Cope
  - * *decorata decorata* (Günther)
  - * *serperaster* Cope
  - *calligaster* (Cope)
  - *decipiens decipiens* (Günther)
  - * *decipiens rubricollis* subsp. nov.
  - * *altamontanus* sp. nov.
  - *pulveriventris* Boulenger
  - *vermiculaticeps* (Cope)
  - * *persimilis* Dunn
  - *pachyura* (Cope)
- Trimorphodon Cope
  - *biscutatus biscutatus* (Duméril, Bibron, and Duméril)
- Leptodeira Fitzinger
  - * *nigrofasciata* Günther
  - *rubricata* (Cope)
  - * *annulata annulata* (Linnaeus)
  - * *ocellata* Günther
  - * *rhombifera* Günther
  - *maculata* (Hallowell)
- Oxybelis Wagler
  - *fulgidus* (Daudin)
  - * *brevirostris* (Cope)
  - * *aeneus* (Wagler)

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† A recent work of Mittleman states that the name *doliata* applies to *Cemophora* in which case it will invalidate its use for a species of *Lampropeltis*. However, in neither usage is there absolute certainty. For the time being I shall continue to use the name *doliata* for Costa Rican *Lampropeltis*.

Imantodes Duméril and Bibron
  - * *inornatus* Boulenger
  - * *cenchoa semifasciatus* Cope
  - * *gemmistratus* Cope

Clelia Fitzinger
  - * *clelia clelia* (Daudin)
  - * *petolaria* (Linnaeus)

Erythrolamprus Boie
  - * *bizonus* Jan

Coniophanes Hallowell
  - *decipiens* (Günther)
  - *piceivittis* Cope
  - * *fissidens punctigularis* Cope

Rhinobothryum Wagler
  - *bovalii* Anderson

Conophis Peters
  - *lineatus dunni* Smith
  - *nevermanni* Dunn

Stenorrhina Duméril
  - * *degenhardtii degenhardtii* (Berthold)
  - *degenhardtii apiata* Cope
  - *freminvillii freminvillii* Duméril, Bibron, and Duméril

Scolecophis Fitzinger
  - *atrocinctus* (Schlegel)

Tantilla Baird and Girard
  - * *annulata* Boettger
  - * *armillata* Cope
  - *reticulata* Cope
  - *virgata* Günther
  - * *shistosa* (Bocourt)
  - *ruficeps* Cope
  - * *costaricensis* sp. nov.

Dipsas Laurenti
  - * *anthracops* (Cope)
  - *pictiventris* (Cope)
  - *argus* (Cope)
  - *articulata* (Cope)
  - * *annulata* (Günther)
  - *ruthveni* Barbour and Dunn
  - *costaricensis* Taylor
  - * *tenuissima* sp. nov.

Neopareas Günther
  - *bicolor* Günther

Pelamis Daudin
  - *platurus* (Linnaeus)

Micrurus Wagler
  - * *mipartitus multifasciatus* Jan
  - * *nigrocinctus nigrocinctus* (Girard)
  - * *nigrocinctus mosquitensis* Schmidt
  - *nigrocinctus yatesi* Dunn

nigrocinctus alleni Schmidt
clarki Schmidt
richardi Taylor
pachecoi Taylor
Bothrops Wagler
* *atrox asper* (Garman)
* *nummifer nummifer* (Rüppell)
* *picadoi* (Dunn)
* *nasutus* Bocourt
* *ophryomegas* Bocourt
lansbergii (Schlegel)
* *nigroviridis nigroviridis* (Peters)
* *lateralis* (Peters)
godmani (Günther)
* *schlegelii schlegelii* (Berthold)
* *schlegelii supraciliaris* subsp. nov.
Crotalus Linnaeus
* *durissus durissus* (Linnaeus)
Lachesis Daudin
muta stenophrys Cope

REPORT OF SPECIES

[*Loxocemus bicolor* Cope]

Loxocemus bicolor Cope, Proc. Acad. Nat. Sci. Philadelphia, vol. 13, 1861, p. 77 (type locality La Union, Dept. La Union, El Salvador); Smith and Taylor, U. S. Nat. Mus. Bull. 187, 1945, p. 27; Mertens, Abh. Senckenb. naturf. Ges., No. 487, Jan. 12, 1952, p. 60.

This species may be diagnosed by the following: premaxillary bone toothed; head covered with symmetrical shields; rostral large, projecting; loreal absent; a pair of internasals; frontal in contact with a large occipital shield; pupil vertical; scales smooth, in 31-33 rows; part of rostral visible above one half to two thirds of its distance from prefrontal; frontal separating the parietals, but touching occipital; one or two preoculars, three or four post- and suboculars; supralabials, 9-11; infralabials, 12-13; temporals, 3+3 (or 4). Ventrals, 242-265; anal divided; subcaudals 39-47. Lavender-grey to purplish brown, sometimes with scattered yellow spots.

I regard this as doubtful for Costa Rica.

Constrictor constrictor imperator (Daudin)

Fig. 1.

Boa imperator Daudin, Histoire Naturelle . . . Reptiles, vol. 5, 1803, pp. 150-152 (type locality, "Mexico" restricted to Córdoba, Veracruz, Mexico, by Smith and Taylor).
Constrictor constrictor imperator Taylor, Univ. Kansas Sci. Bull., vol. 34, pt. 1, no. 1, Oct. 1, 1951, p. 29.

Among the snakes of the collection is a small boa (K.U.M.N.H. No. 31944) that was presented alive to me by Sr. Alfonso Trejos

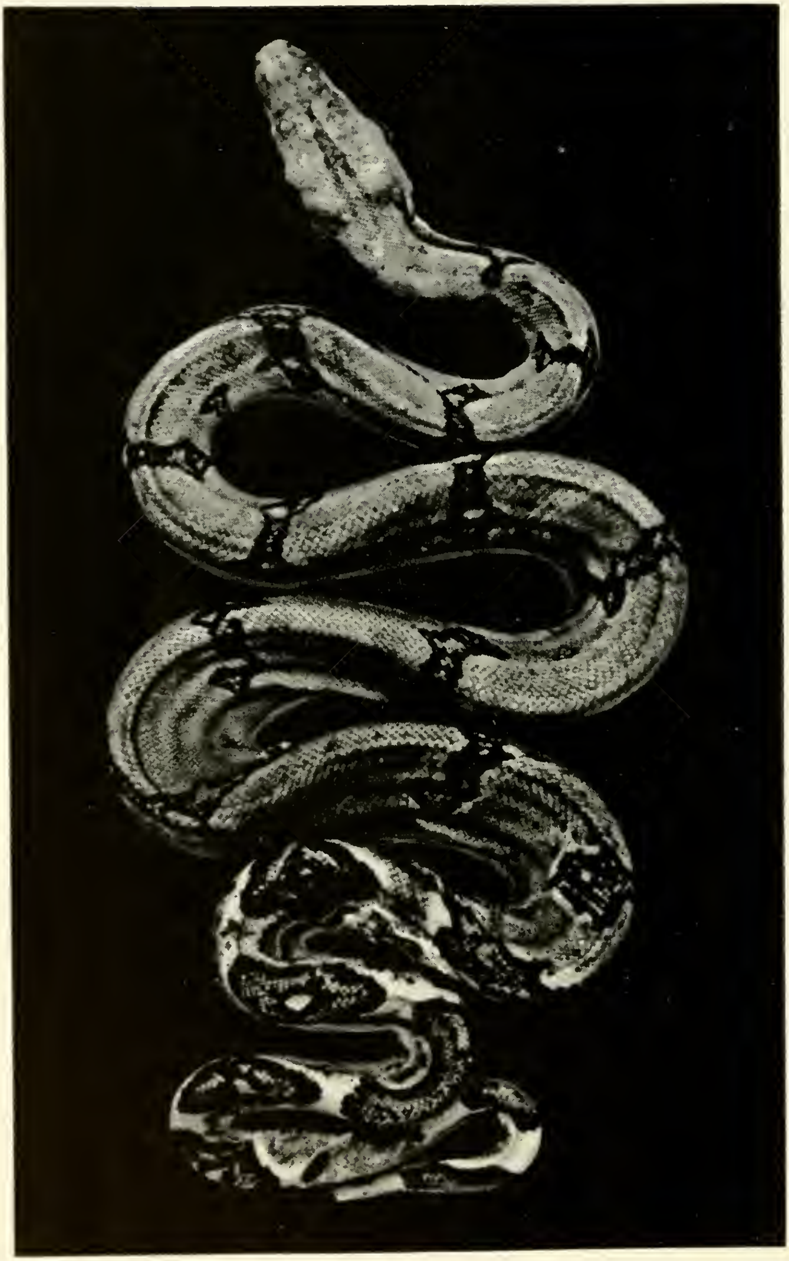

FIG. 1. *Constrictor constrictor imperator* (Daudin). K.U.M.N.H. No. 31944; Costa Rica. This specimen varies from the more typical form occurring in Central America. (About natural size.)

of the Hospital San Juan de Dios, San José, C. R., the snake having been sent, presumably, from some locality in Guanacaste. There are several characters by which it differs from the more typical form. The two most distinctive ones being, a much lighter dorsal ground color, which is rather a lavender-gray and the great reduction in the size of the twelve anterior blotches, which are three to three and a half scale-lengths wide mesially and even on the side are reduced to a maximum width of nine or ten scales. In the more typical form the blotches are usually ten to thirteen scale-lengths wide mesially and laterally 16 to 20. In the typical specimens there is a lateral series of ocellated spots, which in this is barely indicated by scarcely noticeable, shadowlike spots. In this, the ventral surface from chin to past the middle of venter is a light grayish lavender, the fine pigment showing some variation in intensity. The median stripe on the head is dim without a crossbar and the diagonal stripe behind the eye is reduced in width; the black spots on the lower lips (2 on each side) are reduced and relatively dim. There are 13 scales surrounding the eye, three somewhat enlarged preoculars, three suboculars touching labials, two postoculars, of which one is elongate, and five supraoculars.

Two other specimens having the more typical pattern are in the collection: No. 34889 from Turrialba and No. 34901, from Golfito, Puntarenas Province.

Nothopsis torresi Taylor

Nothopsis torresi Taylor, Univ. Kansas Sci. Bull., vol. 34, pt. 1, no. 1, Oct. 1, 1951, pp. 31-34, pl. 1 (type locality, 5 miles SW Turrialba, Costa Rica, Morehouse [not Morehead] Finca).

A single specimen was acquired at Turrialba (K.U.M.N.H. No. 31946). The specimen is a light cream or fawn color with a series of approximately 32 discrete transverse separated brownish blotches, which tend to fork laterally; below each of these is a small darker spot, rarely enclosing a tiny white spot, usually separated from, but may be contiguous with, the dorsal blotch. On tail the spots can be discerned for some distance, then they become obsolete. The head is black.

A well-defined pair of internasals are present, lying rather diagonally, pointed on the outer end, and widened mesially. In the prefrontal area there are approximately 46 scales present, with a median depression anterior to the frontal. The latter scale is bordered by three somewhat enlarged scales anteriorly and is bilobed at its front end, the lobes partially separated. Two small supraoculars, separated from frontal by two rows of small scales, lie above the eye. The parietals are large, separated from the frontal by two or three rows of small scales, and from each other, anteriorly by four rows, posteriorly by one or two rows of small irregular scales. There are two somewhat enlarged postparietals touching the parietals. The nasal is large and at least partially divided. In the loreal region there are several somewhat enlarged scales. A total of about 17 scales encircle the eye, and represent the supra-, pre-, sub-, and postoculars. The labials are separated from these by two rows of small scales; there are twelve supralabials, and 13-14 infralabials. The scales about the back of head number 33, about neck and anterior part of body 26, about middle of body 28, on the latter fourth 26, in front of tail 24. The ventrals are 153, anal single, the subcaudals 88, of which the first is undivided. The maxillary teeth are 21, the two at the end of the series somewhat enlarged. The characters in which this specimen seems to differ from the type of *N. torresi,* are a differently shaped nasal scale, very differently shaped internasal scales; the absence of an enlarged supraocular and the presence of 28 instead of 26 rows of scales at midbody.

The ventral and subcaudal counts in the type and this specimen are, ventrals 149 and 153; subcaudals 71 and 88. Totals 220 and 241.

The general character of the body scales and the smoothness of the anterior head scales is similar to those of *torresi.*

Until a series of these strange snakes can be assembled from a single area it will be impossible to determine whether we are dealing with a highly variable species, or whether these represent two separable populations.

I am tentatively associating this specimen with *Nothopsis torresi.*

Scaphiodontophis venustissimus (Günther)

Fig. 2

Henicognathus venustissimus Günther, Biologia Centrali-Americana; Reptilia and Batrachia, Oct. 1894, p. 144, pl. 51, fig. C (type locality, Matagalpa, Hda. Rosa de Jerico [3,250 ft.], Nicaragua).

Scaphiodontophis venustissimus Taylor, Univ. Kansas Sci. Bull., vol. 34, pt. 1, no. 1, Oct. 1, 1951, pp. 35-36 (incorrectly attributes the name *Hemicognathus* to Günther [*error typ.*]).

Two specimens, K.U.M.N.H. No. 31932 from San Isidro del General, and No. 31933 from Tenorio, Las Cañas, Guanacaste, Costa Rica, are in the collection.

The first specimen is light, the dark marks in rather strong contrast to the lighter red coloration; each scale in the red areas has a discrete dark spot as well as small flecks of black and a fine peppering of dark pigment. The white areas joining the black bars are pigmentless. The venter has considerable pigment scattered on ventrals; a black spot on each subcaudal.

Scale data on this specimen is as follows: ventrals, 136; anal divided; 50 + subcaudals. Maxillary teeth, 51; supralabials, 9-9, the fourth, fifth, and sixth entering eye; infralabials, 11-?, four touching the first chinshields; one preocular; two postoculars. Scale rows smooth, 17-17-17, without pits. The tail has been broken and repaired with a long terminal spike and would appear to be complete. Temporals, 2 + 3.

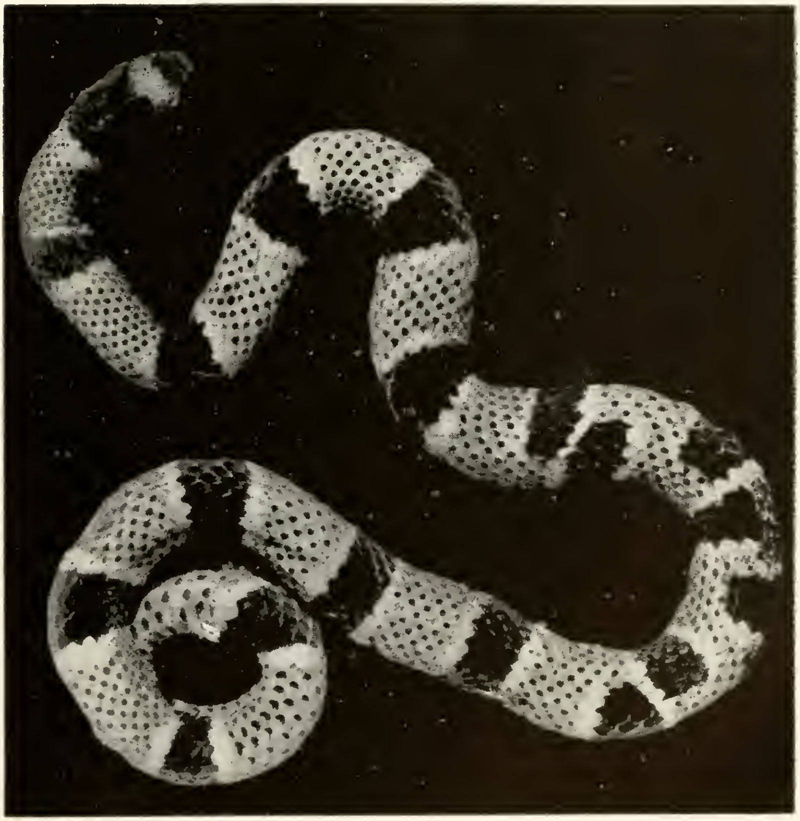

Fig. 2. *Scaphiodontophis venustissimus* (Günther). K.U.M.N.H. No. 31932; San Isidro del General, San José Prov., Costa Rica. (About natural size.)

The second specimen, No. 31933, has the red areas very dark so that the red in life is scarcely discernible, the yellow parts bordering the black bands are likewise heavily peppered with pigment but discernible. The venter is ivory with scattered flecks of bluish black. Tail spotted below.

Scale data: ventrals, 135; anal divided; subcaudals, 107. Scale rows, 17,17,17, without pits; temporals, 1+2+2; supralabials, 9-9, three entering orbit; infralabials, 9-9, four touching chinshields.

No. 31935, discovered under a rock, was caught by the tail, which broke off while the snake was suspended; a second time it was picked up and with little effort the snake freed itself again by breaking off another portion of the tail. A third time the experiment was tried and a third section was severed.

I have not observed this behavior in other species but suspect that as in the case of geckoes this habit may have survival value, since individuals of other species of *Scaphiodontophis* often show mutilated tails. I am not aware that autotomy has been reported in other species or genera of snakes.

On another occasion at the Esquinas Forest Preserve, a young specimen of the species was observed entering a hole. It was seized by the tail and this broke off easily allowing the snake to escape below the root of a forest tree.

Geophis godmani Boulenger

Geophis godmani Boulenger, Catalogue of the Snakes in the British Museum, vol. 2, 1894, p. 322, pl. 16, fig. 4 (type locality, Irazú, Costa Rica).

I obtained a specimen of this diminutive species, 2 miles northeast of Pacayas, Cartago Province, in August, 1951. The specimen, K.U.M.N.H. No. 30957, was taken under a rock on the edge of a small bit of forest.

It agrees with the type in most essential characters. The rostral is somewhat shorter, and the part visible above is approximately one half the distance from the rostral to the frontal. The frontal is slightly broader than long, its length slightly less than its distance from the tip of the snout, and very much shorter than the parietals; the loreal enters the orbit. A minute postocular is present but there is no supraocular or preocular. There are six supralabials in the following order of size: 2,1,6,4,3,5, the third and fourth entering the orbit. The mental is rather pointed at tip and three infralabials touch the first pair of chinshields, which are a trifle larger than the second pair and are not in contact. The following characters are also present: six infralabials; scales in 15 smooth rows; three scales between ventrals and chinshields; 136 ventrals; 27 subcaudals; anal single. Most of the rostral, internasals, first labial and sixth supralabial, cream. The venter is cream-white except for a little dark pigment on widely scattered ventral scales, while under the tail there is much such pigment with a few cream scales. The remainder of the body is black. The length of the specimen is 156 mm., the tail, 18 mm.

This species seemingly remains very rare in collections.

Geophis hoffmanni (Peters)

Colobognathus Hoffmanni Peters, Monatsb. Akad. Wiss. Berlin, 1859, p. 276, pl., fig. 2-2c (type locality, "Costa Rica").

Specimens of this diminutive species were obtained at Bataan (K.U.M.N.H. No. 30928), Turrialba (30929), San José (31987), Cartago (25737), Pacayas (30930), Tenorio (31986), and San Isidro del General (25736, 31985).

No. 30928 is a very small eastern lowland specimen with a broad light band across head and neck over which some pigment is scattered. It likewise has the smallest ventral count (119) (subcaudals 31) and the smallest total ventral-subcaudal count (150). This is approached by that of a specimen from Tenorio, which has 121 ventrals and only 29 subcaudals, but likewise with a total of 150 scales.

Specimens from higher elevations usually have a somewhat higher total, sometimes reaching as high as 164 scales. The second pair of chinshields may be separated in the series. The scales of all are smooth save on the sides near the vent but the keels are very weak in younger females. The specimen from Tenorio has more dark pigment on the venter than any of the other specimens listed above.

Scale data on *Geophis hoffmanni* (Peters)

Number K.U.M.N.H.	*Age or Sex*	*Ventrals*	*Subcaudals*	*Totals*
30928	yg ♂	119	31	150
30929	♂	120	33	153
25737	♂	129	35	164
31987	♂	131	29	160
30930	♂	127	34	161
31986	♂	121	29	150
25736	♂	129	23 +	152 +
31985	♀	132	30	162

Geophis dolichocephalus (Cope)

Colobognathus dolichocephalus Cope, Proc. Acad. Nat. Sci. Philadelphia, Oct. 24, 1871, p. 211 (type locality, San José, Costa Rica).

Geophis dolichocephala Taylor, Univ. Kansas Sci. Bull., vol. 34, pt. 1, no. 1, Oct. 1, 1951, pp. 43-44, pl. 3, fig. 2.

A specimen referred to this species was taken at Moravia de Chirripo (K.U.M.N.H. No. 31988). It differs in color pattern from

Taylor's figure, (*loc. cit.*) in having the red spots obsolete on the neck, and somewhat more numerous on the sides (approximately 25) many of them tending to become contiguous posteriorly.

In the character of the scales of the body, that is, the strong striation and keeling of body scales over much of the body and in having the outer row keeled in the region of the vent, this specimen is typical.

The scales on the neck and anterior part of the body have a tiny tubercle or incipient keel at the base of the scales. There is no evidence of apical pits. The head is narrow and elongate, the frontal, probably abnormally, showing a median ridge.

Geophis moestus Günther

Geophis moestus Günther, Ann. Mag. Nat. Hist., ser. 4, vol. 9, 1872, p. 15 (type locality, Cartago, Costa Rica); Biologia Centrali-Americana. Reptilia and Batrachia, May 1893, pp. 90-91, pl. 33, fig. C. (*part.*); Amula, Mexico, and Cartago, Costa Rica. [The specimen from Mexico may be referable to another species.]).

Geophis moesta Taylor, Univ. Kansas Sci. Bull., vol. 34, pt. 1, no. 1, Oct. 1, 1951, pp. 44 and 46.

A series of specimens from the southern slopes of the Cordillera Central are referred to this species. I also have two specimens from Santa Cruz, southeastern slope of Volcán Turrialba, and one from the southern slope of Volcán Barba, previously reported.

Specimens from the western part of the range are large and robust. The largest, a female, measures 405 mm., total length; tail 60. The tail length in total length varies from 6.1 to 6.8 times in large females. Variation is indicated in the following table. Nos. 30926, 30927, 31991, 6783 are from Pacayas; 31990, 31981 from Cot; 31993, 31994, 31995 from Capilla del Monte La Cruz.

Data and scale counts on *Geophis moestus* Günther

Number	30926	30927	31990	31991	31981	31993	31994	31995	6783
Sex	♀	♀				♀	♀		
Ventrals	136	139	141	138	138	140	146	146	140½
Subcaudals	31	33	32	41	36	35	33	37	32
Supralabials	6–6	6–6	6–6	6–6	6–6	5*–6	6–6	6–6	5–5
Infralabials	6–6	6–6	6–6	6–6	6–6	7–7	7–7	7–7	6–6
Labials enter orbit	3,4	3,4	3,4	3,4	3,4	3,4	3,4	3,4	3**
Labials touch chinshields	3–3	3–3	3–3	3–3	3–3	4–4	4–4	4–4	3–3

Geophis brachycephalus (Cope)

Colobognathus brachycephalus Cope, Proc. Acad. Nat. Sci. Philadelphia, 1871, p. 211 (type locality, Costa Rica).

Geophis brachycephala Taylor, Univ. Kansas Sci. Bull., vol. 34, pt. 1, no. 1, Oct. 1, 1951, pp. 46-48, pl. 4, figs. 2, 3; text fig. 1.

A series of three specimens are in the collection, two, K.U.M.N.H.

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* 5 and 6 fused

** 3 and 4 fused

Nos. 30923, 30924, are from Cervantes and 31989 from 6.5 km. SW Cartago.

The keels are absent from scale rows three and four except in the general region of the vent. None bear pits. Scales in the posterior part of the body and on tail are striated.

The following table (including two specimens previously studied) shows the general characteristics.

Data and scale counts on *Geophis brachycephalus*

Number	840	25735	30923	30924	31989
Museum	R.C.T.	K.U.M.N.H.	K.U.M.N.H.	K.U.M.N.H.	K.U.M.N.H.
Sex	♀	♀	♀	♂	♀
Locality	Santa Cruz	Santa Cruz	Cervantes	Cervantes	near Cartago
Total length	245	230	303	273	181
Tail length	35	24	50	53	28
Body length	210	206	253	220	153
Tail in total length	7	6.4	6.05	5.15	6.4
Ventrals	140	143	139	136	137
Subcaudals	34	35	36	41	37
Anal	1	1	1	1	1
Supralabials	6–6	6–6	6–6	6–6	6–6
Infralabials	6–6	6–6	6–6	6–7	7–7
Labials in orbit	3&4	3&4	3&4	3&4	3&4
Labials touch first chinshields	3–3	3–3	3–3	3–4	4–4
Second chinshields divided	no	no	yes	yes	yes

Geophis bakeri * sp. nov.

Type: K.U.M.N.H. No. 31983, collected July 19, 1952, Cinchona, Isla Bonita (formerly American Cinchona Plantation) Costa Rica, by Edward H. Taylor.

Paratypes: K.U.M.N.H. Nos. 31982, 31984, Isla Bonita, July 19 and 22, 1953, and No. 30940, Pacayas, Cartago, August 6, 1951. Edward H. Taylor, collector.

Diagnosis: A medium sized *Geophis* lacking anterior temporals, preoculars, but with supraoculars, postoculars and internasals present and the first labials in contact behind mental; "pits" present on scales on anterior part of body situated laterally some distance back from tip. Part of rostral visible from above a little more than one third its distance from frontal.

Description of type: Medium large *Geophis* the length of the head (11 mm.) very much greater than width (6.8 mm.); rostral wider than high, the part visible above very bluntly angulate behind, equal to a little more than one third its distance from frontal; a pair of prefrontals wider than long, their suture shorter than visible part of rostral, seen from above, forming nearly equal sutures with the two nasals; prefrontals large, extending much behind their common suture, entering orbit, bordered laterally by loreal and posterior nasal; frontal slightly wider than long, four sided; supraocular small, touching prefrontal, frontal, and parietal; parietals elongate their length equal to their distance from tip of snout; a small postocular touching the supraocular; no preocular or anterior temporal.

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* This species is named for Mr. John Baker, who accompanied the author on the expedition of 1952.

Anterior nasal smaller than posterior; nostril pierced chiefly in the anterior nasal, which touches first labial; second nasal touching two anterior labials; loreal elongate, its length twice its greatest width, third and fourth labials border eye, fifth much the largest, broadly in contact with parietal; one secondary temporal between sixth labial and parietal; the ascending order of size in labials is 1,2,3,4,6,5; six lower labials in the following order of size 2,1,3,6,5,4; first labials elongate transversely, forming a median suture equal to their width. Mental curving (not pointed) anteriorly; first pair of chinshields longer than broad, slightly longer but considerably broader than second pair, which are in contact anteriorly but separated through three fourths of their length by a median smaller scale and separated from first ventral by two median larger scales; scales on body smooth anteriorly, becoming minutely striate and keeled on the latter half of body; scales of anterior part of body and neck with strongly defined paired lateral pits ("apical" pits of authors) the pits situated one fourth to one third of the scale length back from tip; scale formula, 15-15-15; ventrals, 141; subcaudals, 32; anal single.

Color: Above, sides and top of head, entire back and side of body iridescent blue-black, the color extending as small points onto the edges of ventrals; chin and venter white, except for small lines of scattered pigment crossing the anterior part of the scales (but seemingly along their posterior edges), the amount of pigment increasing toward vent, and there covering nearly half of the scale; subcaudal region dark with a trace of a lighter area on each scale; anal scale uniform blackish; area on the anterior pair of chinshields dark; there is less pigmentation on the lower labials and other scales on chin.

Measurements and scale data on *Geophis bakeri*

			Type	
Number	30940	31982	31983	31984
Sex	♂	♀	♀	♀
Total length	355	315	333	191
Snout-vent length	295	265	282	163
Tail length	60	50	51	28
Head width	7.05	6.45	6.8	4.2
Head length	13	10.8	11	7.5
Ventrals	134	141	141	141
Subcaudals	39	35	33	36
Second chinshields separated	partly	partly	partly	no
First labials touch	yes	yes	yes	yes
Scale formula	15–15–15	15–15–15	15–15–15	15–15–15
Apical pits	yes	yes	yes	yes
Tubercles on chin	yes	no	no	no

Variation: The median dorsal ridge is indicated to a greater or lesser extent in all four specimens, although very indistinct in the shortest.

The three topotypic specimens have the apical pits clearly distinguished. A large specimen, No. 30940, taken at Pacayas at a comparable elevation, is a male. The amount of pitting is less and some of the anterior scales have a microscopic tubercle at base; the second lower labial is white. The five anterior lower labials, the chinshields, as well as some adjoining scales, have nuptial tubercles. No. 31982, a female, has less ventral pigmentation than the type taken at the same time and place.

Remarks: The presence of the scale pits has not to my knowledge, been reported in a typical *Geophis* previously and it might be well to re-examine members now recognized as belonging to the genus. Usually the character has been regarded as having a generic significance.

Geophis acutirostris sp. nov.

Fig. 3

Type: K.U.M.N.H. No. 34670. Collected, Cot (Cartago Prov.) approx. 5,500 ft. elev. southern slope of Volcán Irazú; July 2, 1952, Edward H. Taylor, collector.

Diagnosis: A small *Geophis* with internasals absent, probably fused together with anterior nasals, which are narrowly separated mesially by contact of rostral with prefrontal; part of rostral visible above very nearly equal to one half its distance from frontal; supraocular and postocular fused into a single scale curving down behind eye; five supralabials, six infralabials; scales in 15 rows, glassy smooth except for a trace of keels on a few scales above vent.

Description of the type: Rostral higher than wide, the part visible above triangular, pointed behind, touching the prefrontals and separating the anterior nasals; prefrontals very large, rhomboidal, entering orbit for a distance equal to or larger than that of loreal, the median suture parallel with the outer side of scale, the sutures with the nasals parallel with the frontal border; frontal slightly wider than long, quadrangular; suture between parietals less than length of frontal, but total length of scale is slightly greater than its distance from rostral; posterior nasal scales forming straight sutures with labials, prefrontals, and loreals; anterior and posterior nasals separate; loreal very large, its length nearly two and one-half times its width, entering eye; no preocular; no anterior temporal; five upper labials, their sutures usually straight lines, the third and fourth entering eye; fifth labial very much enlarged, touching the combined post- and supraocular at one point; mental rounded rather than pointed anteriorly; six lower labials the first pair transverse forming a broad median suture; first chinshields longer than broad touching three infralabials; second pair of chinshields equally as long, but narrower, in contact by a short suture, with a scale lying between their posterior parts; two other single scales lie between this and first widened ventral.

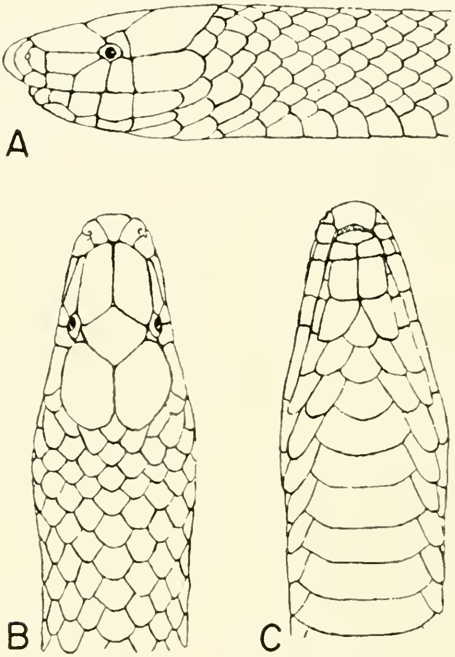

FIG. 3. *Geophis acutirostris* sp. nov. Type. K.U.M.N.H. No. 34670; Cot, Cartago Prov., Costa Rica. (× 5.)

Scales smooth except for a trace of keeling and striation on sides above vent; scale formula, 15-15-15. The ventrals are 130; subcaudals 29; anal single.

Color: Above somewhat iridescent bluish-black, the top of head lighter bluish-black; chin, lower labial, and anterior part of venter cream white, but posteriorly pigment encroaches on the ends of the ventrals; the subcaudal region is much more heavily covered with brownish pigment, the scales with slightly less pigmented centers.

Measurements in mm.: Total length, 237; tail 33; width of head, 4.9; length of head, to the back of jaw, 9.

Remarks: Geophis cancellatus, from Chiapas, Mexico, has the internasals absent. It, however, differs in having six supralabials, 171 ventrals, subcaudals 21-23, and numerous crossbands on body. While the size and ventral subcaudal count is similar to *hoffmanni*, the numerous differences in squamation of the head amply separate them.

The head as figured is somewhat narrower than in life, due to preservation.

Geophis zeledoni sp. nov.

Fig. 4

Type: K.U.M.N.H. No. 31992, Finca Zeledón, between Volcán Barba and Volcán Poás (elev. *circa* 6000 ft.), July 24, 1952, Edward H. Taylor collector.

Paratype: No. 31951, same data as type.

Diagnosis: A rather large *Geophis* with a short head; six (five) upper labials, six lower labials; mental large, pointed posteriorly; first labials in contact or mental separating first labials; supraocular and postocular present; loreal not twice as long as high; scales lacking striations, without apical pits, smooth except that keels are present before and behind level of vent; venter brownish black.

Description of type: Rostral small, its width at base about equal to the height of the scale; part of rostral visible above a little more than one third of the distance from frontal, the scale very obtusely angulate behind; internasals small, transversely elongate; prefrontals large, entering eye, the common suture about three fifths of the length of the scales; frontal nearly as long as wide, its length equals its distance to tip of snout, quadrangular, bluntly angulate anteriorly, somewhat more pointed posteriorly; parietal length less than its distance from tip of snout, separated from eye (entering orbit between the supraocular and the diminutive postocular in paratype).

Anterior nasal smaller than posterior; loreal length less than twice its width, entering eye; no preocular; no primary temporal; one secondary temporal above the fifth labial, longer than high; five supralabials, in the following ascending order of size: 1, 2, 4, 3, 6, 5, the third and fourth entering eye. (In paratype third and fourth fused together.) Diameter of eye about equal to its distance from mouth; length of fourth labial only a trifle greater than its height.

Scales smooth, lacking apical pits and striation; the scale formula, 15-15-15; ventrals 146; subcaudals 40; anal undivided. The outermost row of scales a little the largest over most of the body.

Measurements in mm. of type and paratype: Total length, 397, 359; snout to vent, 327, 296; tail, 70, 63; width of head, 8, 8; length of head, 14, 11; head length to end of parietal, 10.8, 10; tail in total length, 5.67 times, 5.54 times.

Color: Above strongly iridescent lavender brown or lavender black, the head grayish to gray-brown, with a somewhat darker brown area on parietals; chin scales brownish with lighter edges and a blacker area on first chinshield. Venter lavender brown with a few lighter flecks.

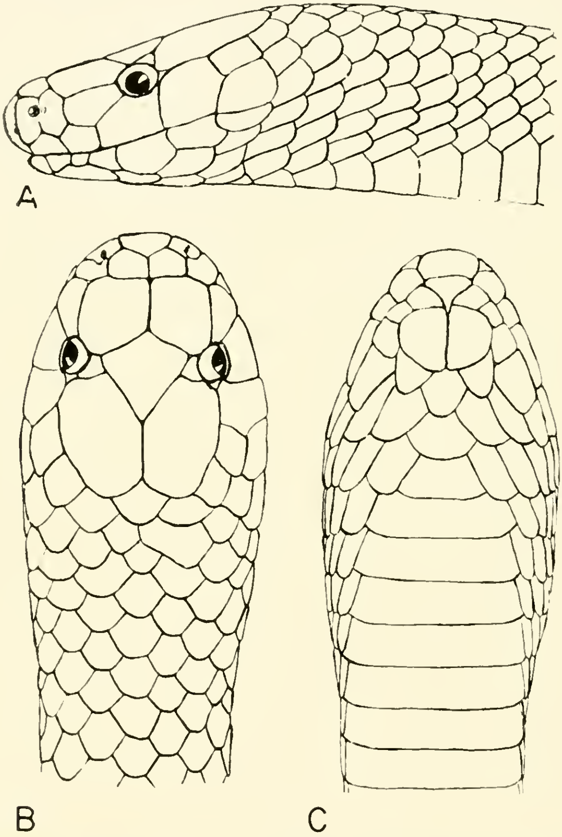

FIG. 4. *Geophis zeledoni* sp. nov. Type. K.U.M.N.H. No. 31992; between Volcán Barba and Volcán Poás, Costa Rica. (×5.)

The paratype agrees in the characteristic coloring of dorsum and venter but the mental does not separate the front labials, the third and fourth labials are not fused, and the postocular is narrow and elongate separating the parietal from orbit. The glassy smooth scales without striations are characteristic of this species.

The dorsals are keeled on the latter sixth of body, near level of vent.

The ventral count is 145½, the subcaudals count 42. The head seemingly is a little broader proportionally and somewhat ultramarine in color. Both holotype and paratype were taken in the same patch of woodland between 5,000 and 6,000 ft. elevation.

The fusion of the third and fourth labials occurs also in a specimen of *moestus;* the reduction of the supralabials in *G. hoffmanni* is due to the reduction posterior to eye, perhaps a fusion of the fifth and sixth. The separation of the first labials by the mental is an unusual variation in Costa Rica *Geophis.*

The species is named for Sr. Don José Zeledón a distinguished Costa Rican scientist who collected and studied Costa Rican reptiles more than 75 years ago.

Ninia sebae sebae (Duméril, Bibron and Duméril)

Streptophorus sebae Duméril, Bibron, Duméril. Erpétologie Générale . . . vol. 7, pt. 1, 1854, pp. 515-517 (type locality, restricted to Veracruz, Veracruz, Mexico by Smith and Taylor).

Ninia sebae sebae Taylor, Univ. Kansas Sci. Bull., vol. 34, pt. 1, no. 1, Oct. 1, 1951, p. 50.

This species is represented in the collection by the numbers, K.U.M.N.H. 31902-31905 from La Lola, Limón Province, at which place it seems to occur rather commonly, according to report.

The specimens agree in having the top of the head black followed by a narrow lighter band. This in turn is followed by a broad nuchal spot reaching on the sides to the first scale row, and extending four to five scale-lengths, this followed by a narrow lighter line. The greater part of the upper and lower labials are without dark pigment except the tip of the chin and the outer edges of the chinshields. There are no other dorsal spots present, the body being dull uniform brownish red, or the red may not be well defined.

The scale formula is, 19-19-19; the ventral-subcaudal counts are given for Nos. 31902-05 respectively: ♀ 138, 58; ♂ 132, 66; ♀ 140, 51 +; ♂ 131, 65.

The youngest specimen, No. 31905, was reddish above, in life, with two yellow bands, one preceding and one following the black nuchal blotch. The venter was pale pinkish, the chin being gray white.

The specimens were found under rotting logs.

Duméril, Bibron, and Duméril give "Mexico" as the type locality for this form, and this has been restricted to Veracruz, Veracruz by Smith and Taylor. The Costa Rican specimens compared with Mexican specimens from lowland Veracruz show certain differences.

The former lack the body bars or spots, and the pigmentation is scattered heavily over the scales, not confined so much to the scale edges. There is even less pigmentation on the edges of the ventrals.

The ventral-subcaudal counts, in the material at hand, compared with counts on 59 specimens from southern Veracruz and four from Chiapas are as follows:

Costa Rica females average	139-58
Chiapas females average	149-45
Veracruz females average	142-47
Costa Rica males average	131-65
Chiapas males average	140-56
Veracruz males average	138-55

In the Veracruz series the range in females is: ventrals 138 to 146; subcaudals 45 to 53; in males, ventrals range from 132 to 145; subcaudals 51 to 62.

From this sample it would appear that Costa Rican specimens have shorter bodies and longer tails than the average of the northern populations. Larger sampling will be necessary to ascertain whether these differences are taxonomically significant.

Ninia atrata (Hallowell)

Fig. 4a

Coluber atratus Hallowell, Proc. Acad. Nat. Sci. Philadelphia, 1854, p. 245 (type locality, Colombia [Venezuela] less than 200 miles from Caracas).
Ninia atrata Taylor, Univ. Kansas Sci. Bull., vol. 34, pt. 1, no. 1, Oct. 1, 1951, pp. 50-51.

One female specimen of this species (K.U.M.N.H. No. 31971) was taken at Cinchona (Isla Bonita), July 19, 1952.

The characteristics of this species follows: rostral broader than high, visible above as a line; internasals a little wider than long, their length equal to slightly less than half of the prefrontals; latter scales a little broader than long, a little less than length of frontal, entering orbit; frontal triangular in shape, as broad as long, with a small entrant suture in front (possibly abnormal); parietals slender, elongate, their length approximately that of the distance between parietal and rostral; nasal at least partly divided, the anterior part slightly the larger, the posterior part somewhat depressed; a small scute notched into the ventral part of nasal (probably segmented from first labial with which it forms a suture); loreal large, its length one and a half times its height, entering orbit; two postoculars, the lower very small, the upper much enlarged; no preocular; temporals 1+2+3; supralabials 7-7, the third and fourth entering orbit, the fifth barely excluded; infralabials 8-8, the first four bordering the first chinshield; first labials in contact; first pair of chinshields wider and longer than second pair; two labials touch second pair.

Scale formula: 19-19-19, all the rows of scales strongly striated and even the keels with striae; ventrals, 125, subcaudals, 38, the anal single.

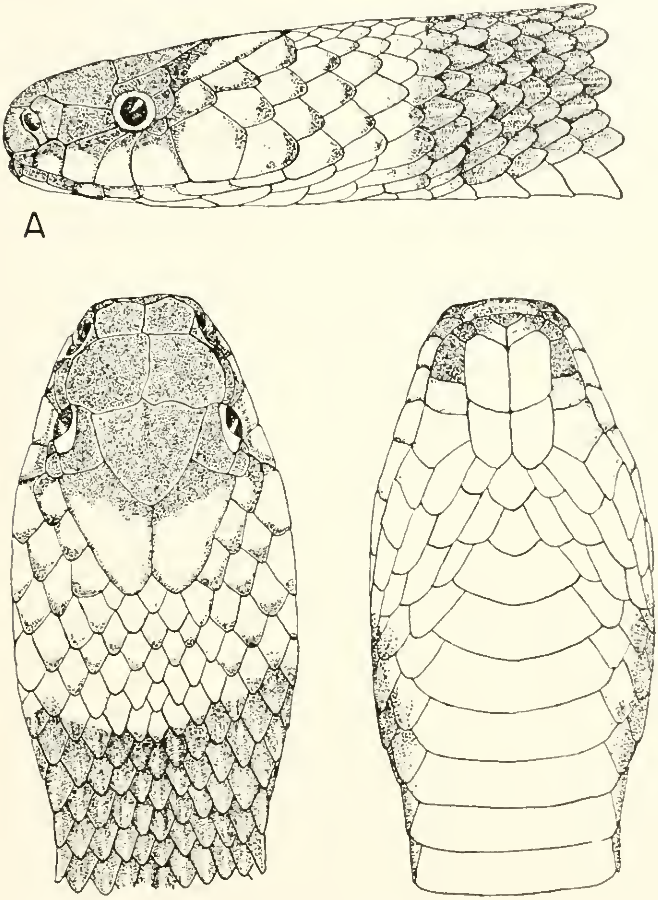

FIG. 4a. *Ninia atrata* (Hallowell). K.U.M.N.H. No. 31971; Cinchona, Costa Rica. (× 5.)

Color in life: Deep black above with a broad bright red-orange occipitonuchal band covering posterior part of parietals, temporals, and four and a half transverse scale rows; each scale of this band with either a dark spot or scattered pigment. Anterior part of head black with some white spots on four labials; area about jaw angle yellow; venter greenish white, slightly pinkish laterally on sides bordering the black; anterior infralabials and the mental with dark marks; flesh white on chinshields, dull yellow elsewhere on chin and below the red-orange band. Subcaudals bluish white, outlined in black, becoming more pronounced posteriorly.

Remarks: The outer parts of the ventrals are strongly striated.

The specimen was taken on the lower part of Cinchona (Isla Bonita) at an elevation of about 4,500 feet.

Ninia maculata (Peters)

Streptophorus maculata Peters, Monatsb. Akad. Wiss. Berlin, 1861, p. 924 (type locality, Costa Rica).
Ninia maculata Dunn,* Proc. Nat. Acad. Sci., vol. 21, no. 1, Jan. 1935, pp. 10-11 (*part.*).

A number of specimens are in the collection from the following localities. K.U.M.N.H. Nos. 31908, 10 mi. WSW San Isidro del General; No. 31909, 7 mi. S Cartago; No. 31912, Finca Quirazú, 4 mi. SW Cartago; No. 31911, Tres Rios; Nos. 31906, 31907, 31910, 31915, 34841-34844, Turrialba.

The eastern lowland species *Ninia tessellata* also occurs at Turrialba and Moravia de Chirripo, each maintaining its distinctive color pattern.

Ninia tessellata Cope

Ninia sebae tessellatus Cope, Journ. Acad. Nat. Sci. Philadelphia, ser. 2, vol. 8, 1876 (1875), p. 145 (type locality, Sipurio, Costa Rica, by inference).
Ninia atrata tessellata Cope, U. S. Nat. Mus. Bull. 32, 1887, p. 74.
Ninia tessellata Taylor, Univ. Kansas Sci. Bull., vol. 34, pt. 1, no. 1, Oct. 1, 1951, pp. 53-54.

A small series of *Ninia tessellata* are in the collection from the following localities: K.U.M.N.H. No. 31929, Cinchona 30935, Morehouse Finca near Turrialba; 30936, Turrialba; 30937, Bataan; 30926, 30928, 30931-30934, Los Diamantes, 2 mi. S Guápiles; 31921-31922, Limón; 31923-25, 31927, La Lola.

I had regarded this form as being lowland but specimens taken at Turrialba, approximately 2,000 feet and Cinchona at approximately 4,500 ft. show that it has a considerable vertical distribution. Two eastern lowland specimens have a small preocular, probably severed from a labial. Another has an upper preocular on each side severed from the section of the prefrontal that enters orbit.

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* Dunn's statement "In Costa Rica *maculata* seems concentrated on the Atlantic-Caribbean slope and *sebae* on the Pacific," may be misleading. *Maculata* occurs on the Pacific slope at San Isidro del General and is absent in the coastal areas of the eastern slope; *Sebae* is common at La Lola in the Caribbean drainage.

In life, specimens are lavender brown to brown with black zigzag transverse bands; below checkered black and flesh or ivory white.

The range of *Ninia tessellata* approaches but probably does not reach as high an elevation as *Ninia oxynota*. Specimens have been taken within a few miles of each other but with a difference of at least 1,500 in elevation. It occurs with *atrata* at Cinchona, and with *sebae* in the eastern lowlands; with *maculata* at Turrialba and perhaps at even higher elevation in the Meseta Central. However, in the region about Cervantes where *maculata* is very common I have not found *tessellata* but *oxynota* occurs within a few miles at perhaps 500 ft. higher elevation.

Ninia oxynota (Werner)

Streptophorus oxynotus Werner, Mitt. Naturh. Mus. Hamburg, Jahrg. 26, 1909 (1910), p. 216, (type locality, Cariblanco, Costa Rica).

Ninia oxynota Taylor, Univ. Kansas Sci. Bull., vol. 34, pt. 1, no. 1, Oct. 1, 1951, pp. 56-58, pl. 6, fig. 2-3.

Two specimens (K.U.M.N.H. Nos. 30956, 31972), were taken at Pacayas, Cartago Province, Costa Rica. The specimens agree well in color pattern with the specimen figured by Taylor (*loc. cit.*). The following scale characters obtain in No. 31972: supralabials, 7-6, the fourth and fifth or third and fourth entering orbit; two postoculars; loreal large, quadrangular; temporals, 1 + 1 (1 + 2); scale rows, 17, 17, 17; ventrals, 159; subcaudals, 70; anal single. Scales very finely striate; outer scale row keeled except on neck.

No. 30956 ♀. The temporals are 1 + 2; there is a somewhat enlarged scale behind parietals (present in all specimens seen). The ventrals are 158, the subcaudals 77.

In this form there are 10 maxillary teeth diminishing somewhat in size posteriorly. The series extends forward to a point near suture between the second and third labials.

Ninia cerroensis sp. nov.

Fig. 5, 6

Type: K.U.M.N.H. No. 31935 ♂; collected on the Pacific slope of Cerro de la Muerte, at an elevation of approximately 7,500 feet (on Pan American Highway) by Edward H. Taylor.

Diagnosis: A species related to *N. psephota* Cope, but differing in having the outer scale row keeled and lacking the black dorsal coloration and red ventral coloration.

A very narrow nuchal yellow band, scarcely 1 scale-length wide, interrupted mesially; 17 scale rows throughout, the tips with a small transparent lobe or extension; supralabials and infralabials, 6; nasal divided; 14 maxillary teeth, slightly larger near middle of series.

Description of type: Rostral a half wider than high, its upper surface rounded, not angulate; internasals much wider than long, their length somewhat more than a third of the prefrontal length;

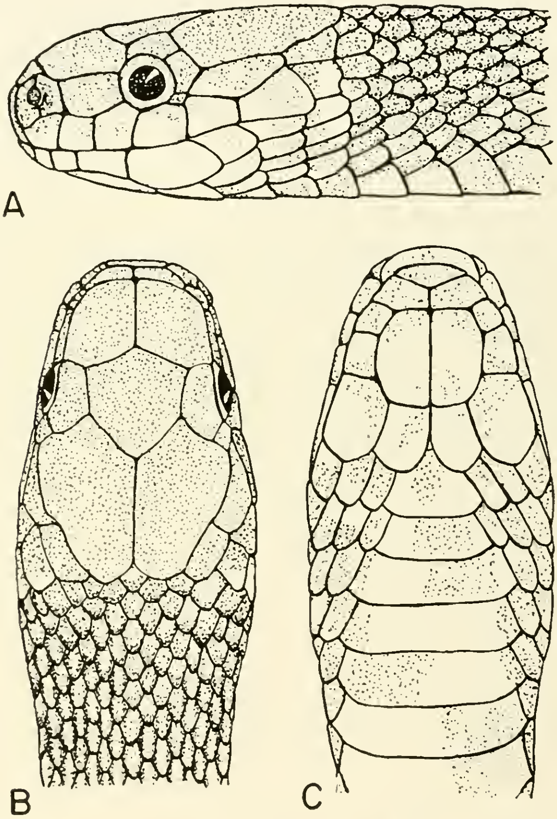

FIG. 5. *Ninia cerroensis* sp. nov. Type. K.U.M.N.H. No. 31935; Pacific slope of Cerro de la Muerte, Costa Rica. (× 5).

prefrontals distinctly longer than wide, the width equal to length of their common suture entering orbit; frontal hexagonal, the width equalling length which is less than that of prefrontals; supraoculars longer than wide, their width less than half that of frontal; parietals elongate, their length equalling their distance from tip of snout; nasal divided, the anterior about equal to posterior; the posterior part touching two labials; loreal large, nearly rectangular, its length a fifth greater than its height; postoculars, 1-2, elongate, somewhat curving (on the left side there is a very small lower postocular); temporals, 1 + 2, the anterior large, elongate; the two posterior lie almost behind the last supralabials; six upper labials in the following order of size: 1, 2, 3, 4, 5, 6, the last much enlarged, the third and fourth entering orbit; eye moderate, its diameter less than distance to nostril; six infralabials, the first pair in contact, the first three touching first chinshields, the fourth much enlarged, touching

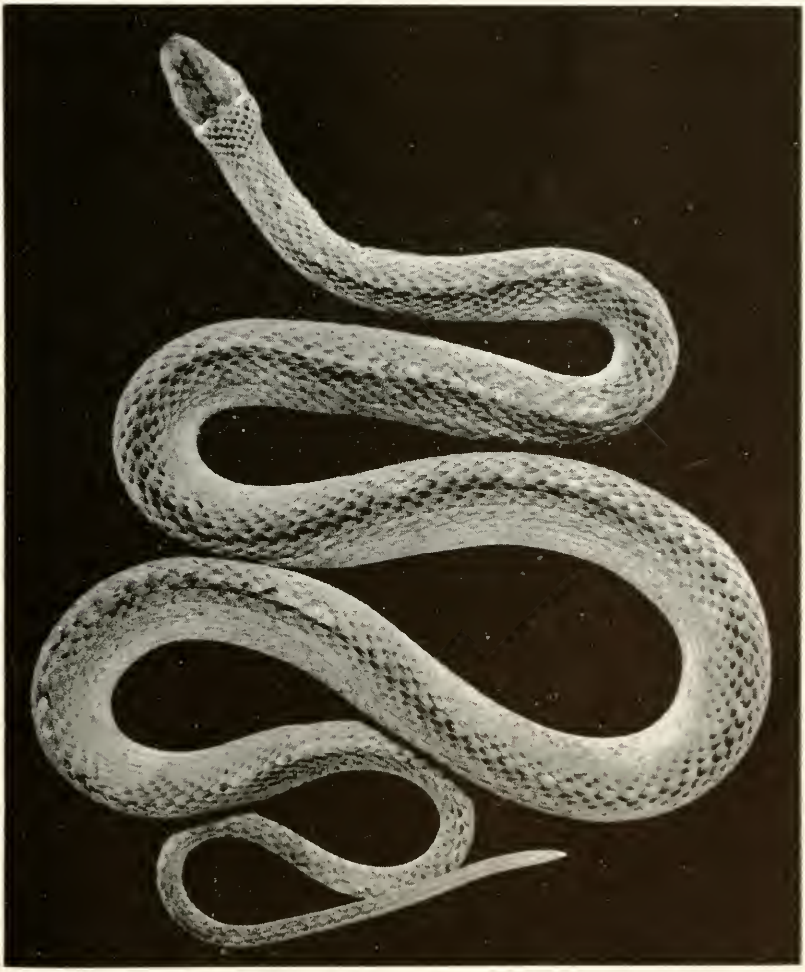

FIG. 6. *Ninia cerroensis* sp. nov. Type K.U.M.N.H. No. 31935; Pacific slope of Cerro de la Muerte, Costa Rica. (Somewhat enlarged; actual length 494 mm.).

second chinshields. First chinshields a third longer but scarcely wider than second pair, which are in contact; scales immediately following are wide, similar to ventrals; scale rows on back of head, 19; on body, 17, 17, 17; all scales keeled but without striation or apical pits; ventrals, 160½, (counting from second chinshields); subcaudals, 60; anal single.

Color in life: Above nearly ultramarine on body, the color extending onto ventrals a varying distance; a narrow yellow nuchal collar interrupted mesially by the parietal tips; color of top and sides of head gray-blue, each of the supralabials showing a cream spot; a small indistinct light spot on temporal and outer edge of parietal; infralabials and chinshields with cream spots, the six most prominent being a pair on first chinshields, and four in a row on fourth labials and second chinshields; the areas on ventrals not covered with body color are yellow cream; underside of tail slate gray, with some suggestion of lighter centers anteriorly, and posteriorly, the edges have a suggestion of darker borders. There are no cream spots as occurs in *oxynota.*

Measurements in mm.: Total length 494; tail 123; width of head 8.5; length of head 14.

Remarks: The species has the body somewhat triangular in cross-section. When the epidermis is removed the color is the same; but if the surface of the scale is abraised or scraped, the color below is deep black.

The ventral markings seem very haphazard, compared with *oxynota* where the white or dark color of the venter either crosses the ventral completely or is severed on the median line leaving the scale half light, half dark. The series of yellowish transverse bands on the body in *oxynota* are completely lacking in this form.

Ninia psephota has the color of the dorsum black and of the venter black and red. The outer scale row is smooth, the others keeled. The following characters of *cerroensis* also differ from the type of *psephota.* The maxillary teeth do not extend as far forward; frontal angular, rather than convex on anterior border; the nasal divided rather than single; the temporals larger, lacking tertiary temporals. There are no spots on the subcaudal region.

The type of *psephota* is from 5,000 to 7,000 feet elevation on Pico Blanco (Caribbean drainage); *cerroensis* seemingly replaces it at similar elevation in the Pacific drainage of the Talamanca range.

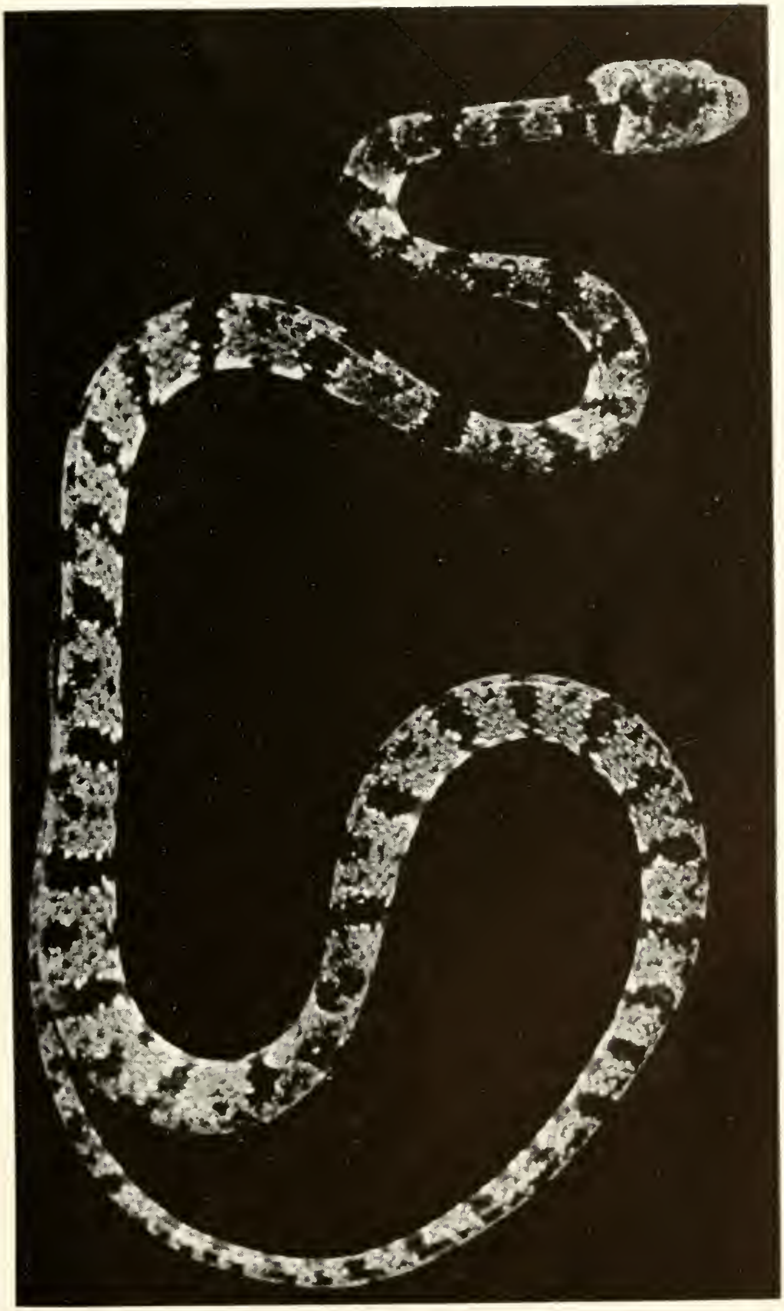

FIG. 7. *Sibon nebulatus* (Linnaeus). K.U.M.N.H. No. 31936; Los Diamantes, near Guápiles, Limón Prov., Costa Rica. (Somewhat enlarged).

Sibon nebulatus (Linnaeus)

Fig. 7

Coluber nebulatus Linnaeus, Systema Naturae ed. 10, vol. 1, 1758, p. 222 (type locality "Africa" in error. Restricted to Jicaltepec, Veracruz by Smith and Taylor.)

Dipsas nebulatus Dunn, Copeia 1947, no. 3, pp. 157; Ecology, vol. 30, 1949, pp. 39-57.

Sibon nebulatus Taylor, Univ. Kansas Sci. Bull., vol. 34, pt. 1, no. 1, Oct. 1, 1951, pp. 67-68.

Two specimens were taken, K.U.M.N.H. No. 31936, July 26, 1951, Los Diamantes, near Guápiles, Costa Rica, and No. 31937, at the Inter-American Institute of Agriculture, Turrialba, June 2, 1951.

This snake, with a range from Mexico to Brasil, seemingly does not diversify, into subspecific forms, the characters remaining rather constant.

Significant characters not mentioned by me (*loc. cit.*) are the much enlarged median scale row, the narrow neck, and compressed body. Many snakes with laterally compressed bodies are arboreal. The specimens I have found were on the ground, and none in trees, although it is probably arboreal. A third specimen, taken at Tenorio by John Baker, escaped from a faulty collecting bag.

These specimens agree with the characters offered (Taylor *loc. cit.*) save that the nasals are seemingly not completely divided. Supralabials, 7-7, the fourth and fifth entering orbit; infralabials, 8-8, the first four touching the first pair of chinshields in one, by five in the other (No. 31937). In this specimen the second chinshields are absent, the one on the right is fused to the anterior, the one on the left seemingly is fused to the third; No. 31936 has three pairs of chinshields. The latter specimen has: 178½ ventrals; anal single; 100 subcaudals; the former 188 ventrals; anal single; 100 subcaudals. The spotting and general coloration differs but little in the two specimens.

Xenodon bertholdi Jan

Xenodon Bertholdi Jan, Arch. per la Zool., 1863 pp. 318-319 (type locality "Mexico"). Taylor, Univ. Kansas Sci. Bull., vol. 34, pt. 1, no. 1, Oct. 1, 1951, p. 69.

Two specimens Nos. 31963 from Turrialba, No. 31979 from Estrella (Limón Province). The ventral-subcaudal counts are respectively 150-45, and 148½-44. The character of the pattern of the larger specimen is shown in the illustration.

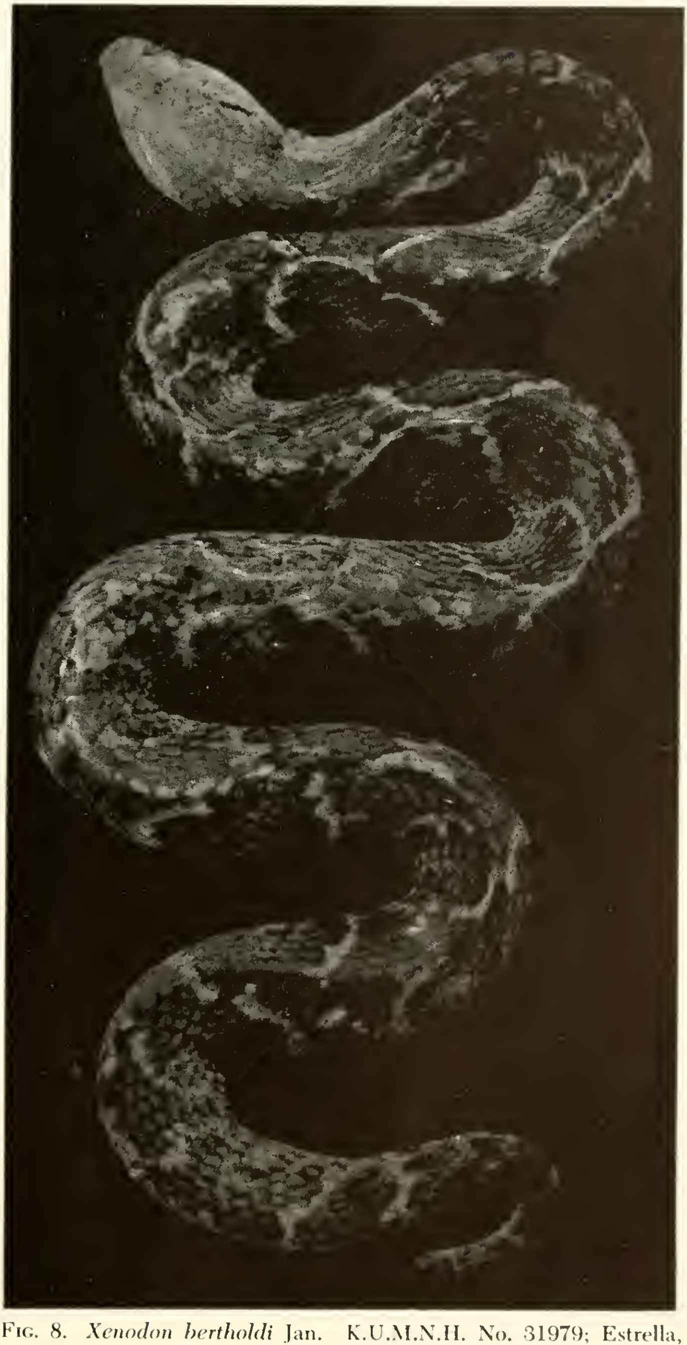

Fig. 8. *Xenodon bertholdi* Jan. K.U.M.N.H. No. 31979; Estrella, Limón Prov., Costa Rica.

Xenodon colubrinus Günther

Xenodon colubrinus Günther, Catalogue of the colubrine snakes in the collection of the British Museum, 1858, pp. 55-56 (type locality, Pará).

Xenodon colubrinus Taylor, Univ. Kansas Sci. Bull., vol. 34, pt. 1, Oct. 1, 1951, pp. 69-70.

The material of this genus in Costa Rica seemingly resolves into two species, *Xenodon bertholdi* Jan, and *Xenodon colubrinus* Günther. The latter appears to break up into an eastern and western group having the following characters:

K.U.M.N.H. Nos. 30922 and 31980 from Turrialba. In these specimens there is a blackish mark that takes its beginning on the frontal but, not covering the whole of it, sends out two slight projections onto the supraoculars, widening as it moves backwards until it covers the dorsal surface of the neck. It passes back onto the neck for an inch and surrounds two lighter stripes about an inch long. The black median part has a narrow entrant gray line in No. 30922 but this cannot be discerned in No. 31980. The venter and subcaudal region are light with some clouding barely indicated. The dorsal blotches are 11 and 13, none broken on the median line of body. Ventrals and subcaudals are respectively: 147—44; 147—45. Both are females.

The other, western, group is well represented by four specimens, Nos. 31964 ♀, 31966 ♂, San Isidro del General; No. 31965 ♀, Tenorio, and No. 34839 ♀, Golfito. The heads in these are light olive tan with minute black flecks or dots forming a more or less symmetrical design. The first (nuchal) spot does not connect with a head spot. It encloses one or two gray ocelli on the midline. The blotches are 11 to 13, none being divided mesially. The venters are heavily pigmented, the two smaller specimens having the pigment somewhat denser on the middle third of the ventrals. The Tenorio specimen has the venter equally gray but in another specimen (a large female from San Isidro del General), the venter is as light as in the eastern specimens but the head pattern conforms to that of the western specimens. In all, the subcaudal region is light. The ventral-subcaudal counts of the four specimens are: 151—48; 138—46; 146—48, and 148—46. Most of the specimens have four to eight pairs of the terminal subcaudals with convex surfaces and present, to a greater or lesser degree, in both sexes. The dentition in one specimen shows 15 smaller subequal teeth; and two large ungrooved fangs, the posterior edges of which are sharp.

The Tenorio specimen had eaten a *Bufo haematiticus,* which it disgorged in the collecting sac.

Enulius sclateri (Boulenger)

Leptocalamus sclateri Boulenger, Catalogue of the Snakes in the British Museum, ed. 2, vol. 2, 1894, p. 251, pl. 12, fig. 1 (type locality "South America"); and vol. 3, 1896, p. 641 (Guasima = Guásimo, Costa Rica).

Enulius sclateri Taylor, Univ. Kansas Sci. Bull., vol. 34, pt. 1, no. 1, Oct. 1, 1951, pp. 71-74, pl. 8, and text fig. 3.

Enulius slateri (*sic.*) Dunn, Ecology vol. 30, no. 1, Jan. 1949, pp. 51-53, 54, 55 (Mentions certain specimens taken in Panamá).

This small snake species was taken at two Costa Rican localities, K.U.M.N.H. No. 34047, San Isidro del General; Nos. 34048, 34049, Turrialba. There is some evidence of geographical variation in the ventral counts and there are certain obvious differences in coloration.

In squamation of the head, the three specimens do not differ markedly in any character save that No. 34047 has a distinctly wider and lower rostral, and the snout does not extend quite so far forward.

In my description *loc. cit.* I state that there are four pits in the anterior scales. A re-examination of this specimen shows that this statement is not true. The appearance of four is illusory. There are two "pits" which in certain light appear as two lighter dots and preceding these is a similar pair of dots. In the examination of the shed scale there is no evidence of the anterior pair. Held in certain lights the scale surface shows only two surface irregularities.

The pits are usually absent from the three outer scale rows. Many scales have only a single pit (on one side or the other) just before they reach the end of their distribution posteriorly.

One specimen from Turrialba is generally ultramarine in color with the dorsal scales finely peppered with very fine pigment more intense anteriorly, practically absent posteriorly; on the neck, the color reaches as low as the third scale row. The head and chin are cream-white extending behind parietals for three or four transverse scale rows. The tip of the snout, and area about the eye, dark, the color extending somewhat into the front edge of the frontal; there is a white spot indicated on the prefrontal in front of eye. The second specimen, somewhat larger, has been darkened by formalin preservative, but the character of the head markings is practically the same. In the specimen from the western slope of the Talamanca Mountains at San Isidro del General the head is black to the end of the frontal, the color covering the anterior ends of the parietals, temporals, postoculars, the first three anterior labials, and parts of the fourth and fifth. The frontal is dark. The chin, instead of being immaculate, has the mental and parts of the first two infralabials dark. The remainder of the head is cream-white, the color extending behind parietals to the second transverse scale rows. A small black fleck is present on each side of neck on the white ground. The body dorsally is dark gray, somewhat darker anteriorly. The venter is cream white, the subcaudal region gray, each scale showing a somewhat lighter area.

Table of measurements and scale data of *Enulius sclateri*

	Length	*Tail*	*Ventrals*	*Subcaudals*
34047 ♂	362	152	129½	100
34048 ♂	504	188	150	96
34049 ♂	425	164	150	97
Type ♀	380	150	144	98
Guásimo ♂	...	...	132	?
Los Diamantes ♂	...	...	145	97

I collected the specimen from San Isidro del General in an old rotting stump, and the one from Turrialba in a similar habitat.

Hydromorphus concolor Peters

Hydromorphus concolor Peters, Monatsb. Akad. Wiss. Berlin, 1859, pp. 276-277 (type locality, Costa Rica); Taylor, Univ. Kansas Sci. Bull., vol. 34, pt. 1, no. 1, Oct. 1, 1951, pp. 74-75. (San José, Costa Rica.)

I acquired a young male specimen (K.U.M.N.H. No. 31955) collected in the environs of San José. The head has been somewhat injured. It differs from the type, but agrees with a specimen reported by me (*loc. cit.*) from San José, in having the internasals fused into a single scale, separating the nasals. The exact provenance of the type specimen is unknown and if the character of the divided internasals is constant, the San José specimens may represent a population separable from that to which the type belongs. It is possible that the type is anomalous in this regard.

The characters present in the specimen before me are as follows: Scale formula (19,17),17,15; ventrals, 171; subcaudals, 41; anal and preanal divided; frontal as long as wide; supraoculars slender, curving down slightly at anterior end; loreal entering eye; no preocular; two postoculars; prefrontal large, single; parietals as long as their distance from tip of snout; first chinshields large, a little longer than broad; second pair less than half their size, separated by two median scales; the third pair of scales, likewise separated by two scales; supralabials, 6-6, the third entering eye; infralabials, 8-?, four touching the first chinshields; temporals, 1+2+3.

The color above is purplish slate, nearly uniform dorsally on head and body. The infralabials are dark. On the sides the outer scale rows are somewhat lighter, the first showing but little pigmentation, but on the neck they are nearly of the same color as venter. Below, the venter is light yellowish white with some dark pigmentation on the outer edges of the ventrals and a median series of indistinct flecks from neck to vent. The subcaudal region is uniformly dark. On one side the temporal is pointed anteriorly and seemingly enters the orbit at a single point.

A species of this genus, *Hydromorphus clarki*, has been described from Agua Clara, a village near the Chagres River, Panamá, presumably from a severed head, including some part of the neck (measurements, ventrals, and subcaudal counts not given). This is presumably distinguished from *Hydromorphus concolor* by having only one internasal and one postocular, instead of two of each, and the temporal borders the orbit; the 2½ outer scale rows have the same light color as the ventrals (on the part back of the head).

Dr. Emmet Reid Dunn, the describer, has examined a specimen of *Hydromorphus* from the U. S. National Museum from San José. This specimen also has only a single internasal but he regards it as conspecific with *concolor.* It does, however, have two postoculars instead of having one of them fused to the temporal. In my specimen from San José, the temporal on one side is sharply pointed seemingly entering the orbit at a point between the two postnasals.

I may have here a specimen of *Hydromorphus clarki* Dunn, and if so, the two species will have to be regarded as occurring together at San José since my specimen differs chiefly from the type specimen of *clarki* in having two instead of one free postocular, and in having a body and tail. One might even be justified in suspecting that *clarki* is a synonym of *concolor.*

Trimetopon pliolepis Cope

Trimetopon pliolepis Cope, Proc. Acad. Nat. Sci. Philadelphia, 1894, p. 201 (type locality, San José, Costa Rica, P. Biolley, collector); Cope, Trans. Amer. Philos. Soc., vol. 18, 1895, pl. 30, fig. 1 (hemipenes); Taylor, Univ. Kansas Sci. Bull., vol. 34, pt. 1, no. 1, Oct. 1, 1951, pp. 76-77 (Costa Rican specimens).

This species has been placed by certain authors in the synonymy of *T. gracile* despite the obvious differences in the number of scale rows, *gracile* having 15, *pliolepis* having 17; in the type of *gracile* there are seven supralabials, the third and fourth bordering orbit, in the type of *pliolepis* there are eight supralabials the fourth and fifth bordering the orbit. Four specimens are in the collection, two from Isla Bonita (K.U.M.N.H. No. 34036-37); two from Los Diamantes (Nos. 30955, 34038). The four specimens all have the scale formula, 17-17-17. All have eight supralabials, the fourth and fifth bordering orbit; all show typical lineation of indistinct dark and light stripes on body. Each infralabial has a black spot and the frontal has a pair of light spots.

While the color pattern, scale formula, and conformation of the head squamation is virtually the same in the known specimens, there is some considerable variation in the ventral-subcaudal count suggested. This varies in ventrals from 141 to 154; subcaudals from 59 to 76, with a variation in total count of from 200 to 230. The lowest counts are from the lowlands, the higher counts are from intermediate elevation, the middle counts from the highest localities. The totals 224-230 occur at San José, elev. 1,060 m.; 217, La Palma, 1,980 m.; 214-219, Isla Bonita, 1,520 m.; 200-206, Los Diamantes, app. 250 m. It is possible that much of the variation is sexual.

The following table gives data on the specimens in the collection.

Table of data on *Trimetopon pliolepis* Cope

Number	30955	34038	34036	34037
Locality	Los Diamantes	Los Diamantes	Isla Bonita	Isla Bonita
Sex	♀	♀	♂	♂
Ventrals	146	145	146	143
Subcaudals	36	61	73	71
Supralabials	8–8	8–8	8–8	8–8
Infralabials	8–8	8–8	8–8	8–8
Preocular	1–1	1–1	1–1	1–1
Postocular	1–1	1–1	1–1	1–1
Scale formula	17–17–17	17–17–17	17–17–17	17–17–17
Frontal light spots	present	present	present	present
Length total	210—tip broken	235	151	242
Tail length	.	60	42	69
Nuchal band divided	yes	yes	yes	yes

Trimetopon sleveni Dunn

Trimetopon sleveni Dunn, Proc. Acad. Nat. Sci. Philadelphia, vol. 92, 1940, pp. 117-118 (type locality "Near Boquete," Chiriquí Prov., Panamá, Alt. 4,000 ft.).

It is with some hesitancy that I associate with this species a snake, which I collected at Isla Bonita, Costa Rica, July 23, 1952, at an elevation of approximately 1,676 m.

The specimen agrees with this species in having a scale formula of 17-17-17, one preocular, two postoculars, seven supralabials, the third and fourth entering eye, seven or eight infralabials, the first three or four touching chinshields, paired prefrontals, paired internasals, and one loreal. There are paired light spots on the neck. No pits are discernible on the scales. The specimen shows no lateral keeling above the vent. The ventrals are 164, and 53 subcaudals; the anal is divided.

Above, the specimen is very dark but when submerged a median and two darker lateral lines are discernible with lighter lines between. The markings on the head agree with the type description except for some small whitish spots on the internasals. The chin is white but there is black spotting on the scales of the lower lip and chin, back as far as the eighth infralabial. The body and tail are reddish below.

One could scarcely expect greater conformity in specimens from widely separated localities. The head is rather short. The total ventral-subcaudal count is 217 ♂, while in the types and paratypes it is 213 ♂, 209-211 ♀. The maxillary teeth are 12, gradually increasing to the last but they are less robust than in *gracile*.

This is the first record of the species in Costa Rica.

Trimetopon gracile (Günther)

Ablabes gracilis Günther, Ann. Mag. Nat. Hist., ser. 4, vol. 9, Jan. 1872, p. 18, pl. 3, fig. D. ("Elevated country near Cartago")

Trimetopon gracile Cope, Proc. Amer. Philos. Soc., vol. 22, 1884 (Mar. 7, 1885 *), p. 177; Taylor, Univ. Kansas Sci. Bull., vol. 34, pl. 1, no. 1, Oct. 1, 1951, pp. 79-80.

A single specimen taken near Empalme on the Pan-American Highway south of Cartago, Aug. 1951, by John Reark, and presented to me, agrees with Günther's type in essential characters.

Since Dunn and others have confused this species and *pliolepis*, I append a description of the specimen.

Scale formula, 15-15-15; head rather elongate; two internasals, one prefrontal; one preocular; one postocular; temporals, 1 + 1 + 2; seven supralabials, the third and fourth entering orbit; mental and first three infralabials with black spots; no frontal spots; two separated light spots on nape, diagonally placed, converging forward, separated by a median dark line; a line across temporal region to behind jaw angle. Some suggestion of lineation on body with a darker line on edge of ventrals and one on the third and fourth scale rows.

Ventrals, 153; anal divided; subcaudals 47 + (tip missing); total length 260 + mm.; tail 53 + mm.; head length 9.5 mm; width of head 5 mm.

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* Date on the cover of separate, June 30, 1885. The genus is diagnosed, with *gracile* as the type. "Two internasals; one prefrontal plate. Two nasals; rostral not produced; a loreal, and one preocular. Scales smooth, with one pore. Anal divided."

This specimen in life had a yellow border on rostral, yellow spots on four anterior supralabials, and an elongate cream mark from eye across the fifth and sixth supralabials; head blackish anteriorly and brownish on prefrontals, frontals, and parietals; the cream color of chin pushes up over jaw angle; anterior part of venter cream-white, posterior part reddish; subcaudal area bluish white, with some scattered dark pigment.

The maxillary teeth are 12, gradually increasing in size to last; teeth, without a diastema.

Hypsiglena torquata torquata (Günther)

Fig. 9

Leptodeira torquata Günther, Ann. Mag. Nat. Hist., ser. 3, vol. 5, Feb. 1860, pp. 169-171, pl. 10, fig A. (type locality, 2 cotypes, one from Nicaragua, the other from the Island of Laguna, Nicaragua (here restricted to the latter locality).

Hypsiglena torquata torquata Taylor, Univ. Kans. Sci. Bull. vol. 34, pt. 1, no. 1, Oct. 1, 1951 (Costa Rican records).

A specimen collected at San Isidro del General, San José Province, Costa Rica by Lic. Oldemar Chavarria Ch. was obtained by exchange. The specimen now K.U.M.N.H. No. 31930 is faded but the essential characters of the markings are present. The top of the head is tan in color; the outer rims of the parietals are white, which color forms a band of varying width on the neck, partially divided mesially by a short median line of tan, and terminating (mesially) seven scales behind the parietals. The ground color is fawn. A brown line begins behind the eye and continues to the angle of the mouth. There is a median series of somewhat rhomboidal brown spots which are, for the most part, contiguous, forming a distinct zigzag line of unequal thickness, broken at several points and leaving individual spots. There are about 49 spots on the body, and about 28 on the tail. The ventrals are 195½, the subcaudals 101. The anal is divided. There are small brown spots on sides, the lower row most distinct.

The following scale characters obtain: rostral narrowly visible above; internasals large their suture three fifths of length of prefrontal suture; frontal shield-shaped much longer than its distance to tip of snout; supralabials eight, the fourth and fifth enter orbit; infralabials 10-10; two preoculars the upper very large, vertical, touching frontal; temporals, 1+2+3; two postoculars upper largest; second pair of chinshields larger than the first, which touch five infralabials; posterior nasal much larger than anterior; eye large, somewhat less than length of snout. The total length is 247 mm.; the tail 64 mm.

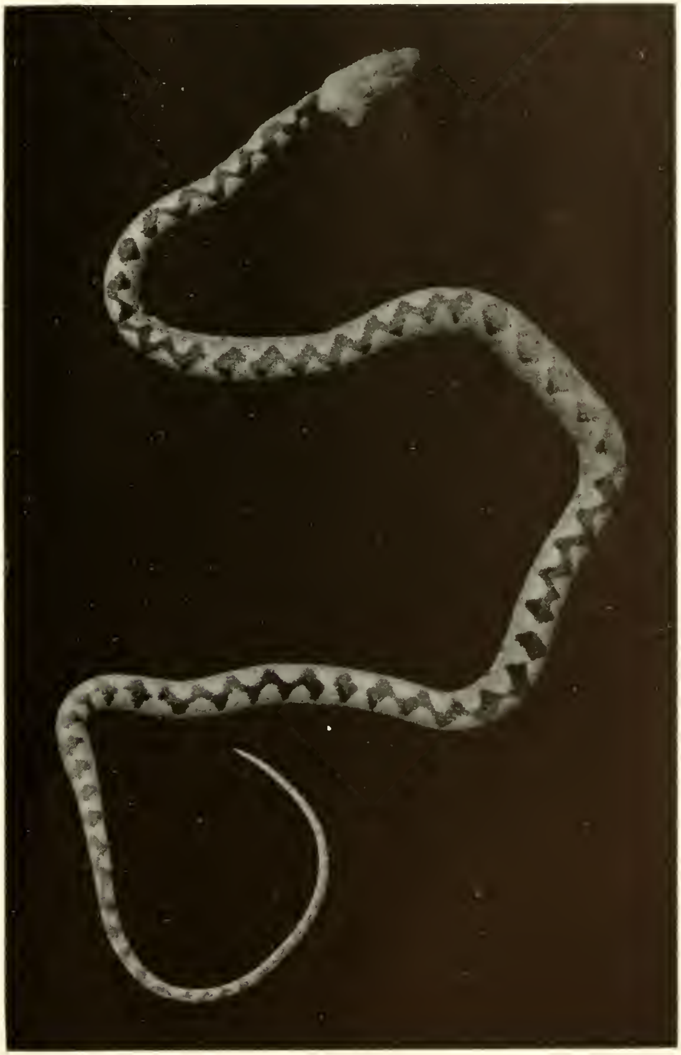

FIG. 9. *Hypsiglena torquata torquata* (Günther). K.U.M.N.H. No. 31930; San Isidro del General, San José Prov., Costa Rica. (Actual total length, 247 mm.).

Amastridium veliferum Cope

Amastridium veliferum Cope, Proc. Acad. Nat. Sci. Philadelphia, 1860, p. 370 (type locality, Cocuyas de Veraguas, New Granada = Cocuyas, Panamá); Taylor, Univ. Kansas Sci. Bull., vol. 34, pt. 1, no. 1, Oct. 1, 1951, pp. 81-82.

Two specimens of a small snake, one K.U.M.N.H. No. 31913 from Isla Bonita and No. 31914 from Turrialba, Costa Rica, are referred to Cope's species *Amastridium veliferum*. This snake is relatively rare in collections and little is known of its habits and habitat. One erroneous statement in the literature is that the species has no apical pits.* Pits are, however, present on scales of the anterior part of the body. The pits are situated not far from the tip of the scale. The specimen from Isla Bonita is from an elevation of a little less than 5,000 ft. It was discovered crawling into a pile of trash in a cultivated area near a forest.

The general characters of squamation differ but little in the two specimens. No. 31913 has the parietal shorter than its distance from the tip of the snout, while No. 31914 has the parietals longer than this distance. Both are males and the scales above the vent on sides are strongly keeled for a distance of an inch or an inch and a half, but dorsally the two or three median rows are keeled for five inches, the keeled scales extending both anterior and posterior to the level of the vent. The maxillary teeth are 11 or 12 followed after an interval by two much enlarged teeth. The pupil is round. The large scale entering the orbit anteriorly is regarded as a preocular rather than as a loreal. In No. 31913 the nasal has a suture from the nostril to the upper edge of scale. This scale in No. 31914 lacks the suture. In this latter specimen the rostral is a little larger, bending on the upper surface of the snout a somewhat greater distance leaving a broadly triangular area instead of a line. (Seen from above, the snout is rather sharply truncate.) Whether these differences are of nomenclatorial significance can be determined only with series of specimens. The difference in elevation between localities where these specimens were taken, is more than 310 m. The localities are approximately 70 km. apart, separated by a chain of volcanoes.

No. 31913 ♂ has the head very distinctly brownish, in strong contrast to body color. The dorsal body color is blackish but when submerged with strong light, four darker lines running the length of the body can be seen. The venter is brownish black with an indistinct darker transverse line on each ventral. Minute yellow dots occur along the fifth row of scales.

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* Dr. Emmet Reid Dunn, who reviewed this species (Proc. U. S. Nat. Mus., vol. 65, 1925), states that *veliferum* has pitless scales. This is untrue as pits are present in the species. A second species, *Mimometopon sapperi*, which Dunn refers to this genus is said to have pitless scales. I have not had occasion to examine the species but if pits are absent and the fang is grooved it might be well to reconsider the generic status of Werner's *Mimometopon sapperi*.

In No. 31914, the darker lines are much more evident, the two median ones joining anteriorly on neck, become more or less broken into a series of blackish dots on back, the median area between them being darker than that between the outer dark lines. In these lighter areas the scales have lighter centers and darker borders. The anterior part of the venter is more grayish, the outer portion of each ventral being observably lighter in color. Other variations are shown in the following table.

Measurements in mm. and data on *Amastridium veliferum*

Number	31913	31914
Sex	♂	♂
Total length	366.3	334
Snout-vent	252	227
Tail	114.3	107
Head to jaw	12	12
Head to end of parietal	10	9.8
Head width	6.8	6.2
Ventrals	129 – 2	126 – 2
Subcaudals	77	80
Anal	2	2
Apical pits	yes	yes
Temporals	$1\ \frac{1}{1-2}$	1 – 1 – 2 $1 - \frac{1}{1-2}$
Supralabials	7–7	7–7
Infralabials	9–9	9–9
Preocular	1–1	1–1
Loreal	0–0	0–0
Postoculars	2–2	2–2
Scale formula	(21–19) 17–17–17	(21–19) 17–17–17

Spilotes pullatus pullatus (Linnaeus)

Coluber pullatus Linnaeus, Syst. Naturae, ed. X, vol. 1, 1758, p. 225; Linnaeus, Museum Adolphi Friderici Regis, 1754, p. 35, pl. 20, fig. 3, (type locality, "Asia," in error, actually unknown).

Spilotes pullatus pullatus Taylor, Univ. Kansas Sci. Bull., vol. 34, pt. 1, no. 1, Oct. 1, 1951, pp. 82-83.

Two specimens of this large snake are in the collection, K.U.M.N.H. No. 34882, from Turrialba, and No. 31970 from between Esparta and Palmares. The ventral and subcaudal counts of these specimens are: 225, anal single, 124; ventrals 218, anal single, subcaudals 124.

The head is generally yellow, with a dark line on most of the prefrontal borders and on the posterior borders of the internasals. A wider, irregular, transverse band crosses the head along the sutures of the parietals with the frontals and supraoculars. A broader irregular band extends across the back of the parietals, across the suture between the seventh and eighth labials, and onto the chin. There are black marks on the sutures of the upper and lower labials, as well as on the other scales of the chin. On the dorsum there are eight or nine yellow spots which may connect with the yellow color on the venter. The anterior ventrals are yellow and black, the yellow predominating anteriorly but gradually becoming darker, posteriorly, the yellow not extending beyond ventral no. 117. Except on the neck, the scales are strongly keeled, each with paired pits, the pits on scales extending throughout the body and tail.

The younger specimen has the keels less distinct and the yellow spots on the back are more diffuse. The frontal is much longer than wide. The infralabials are 9-9, five touching the first chinshields. The yellow color ceases at ventral no. 121.

Leptophis * *mexicanus mexicanus* Duméril, Bibron and Duméril

Fig. 10

Leptophis mexicanus Duméril, Bibron, and Duméril, Erpétologie Générale . . . vol. 7, pt. 1, 1854, pp. 536-537; *Thalerophis m. mexicanus* Taylor, Univ. Kansas Sci. Bull., vol. 34, pt. 1, no. 1, Oct. 1, 1951, pp. 84-85.

A specimen K.U.M.N.H. No. 31947 ♂ was captured at the mouth of the Río Barranca, (Hotel Maribella), Puntarenas Prov., Costa Rica. The specimen agrees with data in Taylor (*loc. cit.*) for the most part.

The rostral is visible as a small triangle, seen from above, and the frontal one-third longer than broad, slightly longer than its distance from end of snout. The first temporal is twice as long as wide. The temporal formula is 1 + 2, preoculars, 1-2 (broken on right side). The second pair of chinshields is much longer than first, and the scales are touched by five infralabials. The length of the eye is equal to its distance from nostril. The formula for body scales is 15, 15, 11, all of the scales keeled save those on outer row, and most of those on the anterior part of the body have a single well-defined apical pit. The ventrals are 158, subcaudals, 155, the anal divided. The ventrals are laterally angular with an indefinite broken lighter streak along the keels.

In life the specimen was bronze-brown above with a black lateral stripe, bordered below by an ivory line covering outer scale row and a part of the second row. The venter is ivory, becoming bronze-ivory posteriorly.

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* In a recent publication Mr. J. Savage has re-examined the evidence for using *Leptophis* for this group of arboreal snakes. He concludes that this name must replace *Thalerophis* proposed for the group by Dr. James A. Oliver, Bull. Amer. Mus. Nat. Hist., vol. 92, art. 4, 1948, pp. 167-172.

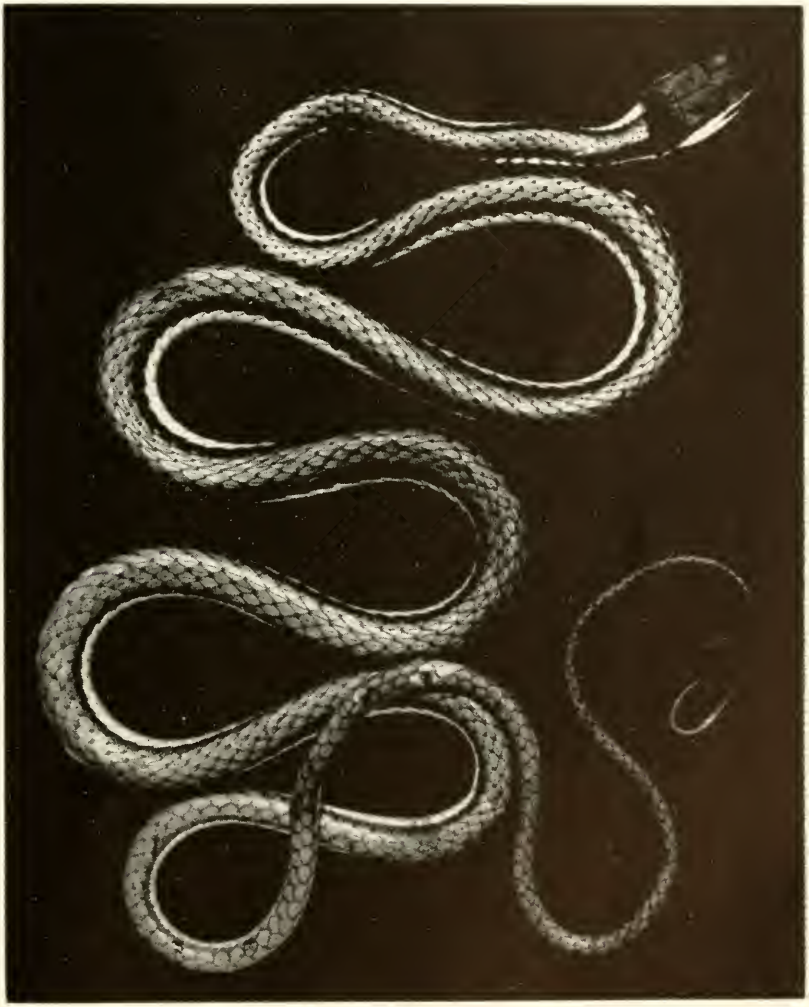

FIG. 10. *Leptophis mexicanus mexicanus* Duméril, Bibron, and Duméril. K.U.M.N.H. No. 31947; Mouth of Río Barranca, Puntarenas Prov., Costa Rica. (Actual total length, 988 mm.)

The specimen was discovered in a small tree near the seashore by John Baker. With considerable difficulty, the two of us chased the snake from one part of the tree to another and finally it was jerked to the ground with a long pole of bamboo, and captured.

Leptophis nebulosus Oliver

Leptophis nebulosus Oliver, Occ. Papers Mus. Zool. Univ. Michigan, no. 462, 1942, p. 12, fig. 4. (Type locality, Cariblanco, Costa Rica.)

Thalerophis nebulosus Taylor, Univ. Kansas Sci. Bull., vol. 34, pt. 1, no. 1, Oct. 1, 1951, pp. 85-86.

A young specimen from Golfito, Costa Rica, K.U.M.N.H. No. 34835, seems to be the second specimen of this species reported from Costa Rica, the first being the type from Cariblanco. Oliver reports a specimen from Patucá, Honduras, and three specimens from Nicaragua, with two definite localities (Greytown and Matagalpa). The specimen at hand extends the range to southwestern Costa Rica.

The specimen agrees rather well with the type description. The following characters are present:

The loreal is absent; preocular touching frontal; prefrontals longer than internasals; frontal nearly a half longer than its distance from tip of snout, as long as parietals; temporals, 1+2; supralabials, 8-8; infralabials, 10-11, five or six touching first chinshields which are smaller than second pair; second pair of chinshields separated; ventrals, 162; subcaudals, 179; ventrals angular; a light lateral stripe on outerpart of ventrals and on first and part of second scale row; chin and throat white; a dark stripe from eye across jaw angle and onto side for a short distance.

The specimen was collected by Mrs. Albert E. Weyer.

Leptophis ahaetulla occidentalis (Günther)

Ahaetulla occidentalis Günther, Proc. Zool. Soc. London, 1859, p. 412 (type locality, Guayaquil and western Ecuador).

Thalerophis richardi occidentalis Taylor, Univ. Kansas Sci. Bull., vol. 34, pt. 1, no. 1, Oct. 1, 1951, p. 86.

Four Costa Rican specimens of this species have been acquired: K.U.M.N.H. Nos. 30996, 34044, Turrialba; No. 34043, Cariblanco, and No. 31958, Golfito. Two of these were taken on the ground in forested areas; two were on plants overhanging flowing water.

The variations in scale data are indicated in the following table:

Data on *Leptophis ahaetulla occidentalis*

	Sex	*Ventrals*	*Anal*	*Subcaudals*	*Supralabials*	*Infralabials*
30996	♂	166	1*	159	9–9	10–10
31958	♂	165	2	169	8–8	10–10
34043	♀	152	2	157	8–8	9–9
34044	♂	155	2	140+	8–8	9–9

* Anal single.

Anteriorly on the neck the keels on the scales of the female are absent, then they suddenly appear on the five median rows about three inches from the head; then at five inches back from head all except first outer row is keeled, the second being rather faintly keeled throughout.

In males the keels begin behind parietals and are heavier than in the female.

Leptophis ahaetulla praestans (Cope)

Thrasops praestans Cope, Proc. Acad. Nat. Sci. Philadelphia, vol. 20, 1868, p. 309 (type locality, Petén, Guatemala).

Leptophis praestans Cope, Journ. Acad. Nat. Sci. Philadelphia, ser. 2, vol. 8 1876 (1875), p. 133 (Sipurio, Costa Rica); U. S. Nat. Mus. Bull., 32, 1887, p. 69 (east Costa Rica, Gabb. coll.; Guatemala, Hague coll.).

Thalerophis richardi praestans Oliver, Bull. Amer. Mus. Nat. Hist., vol. 92, 1948, pp. 248-250.

In the recent revision of the genus *Thalerophis*, Oliver has not accounted for the reference of Cope to a specimen of this species in Costa Rica and it is possible that it has been overlooked. I have recently taken a specimen of this large tree snake at Tenorio, Las Cañas, Guanacaste (K.U.M.N.H. No. 34902). A second specimen, No. 34898 from Turrialba, was obtained by exchange with Mr. Kenneth Olson. A brief description is appended of the former specimen.

The part of rostral visible above equal to about one third of the length of internasals, the width a little greater than height; internasals much shorter than prefrontals; frontal length equal to its distance from tip of the snout, slightly shorter than parietals that are approximately as wide as long, their length equal to their distance to middle of prefrontal; nasal elongate, divided; no loreal, the prefrontal touching second, third, and fourth labials; preocular large, widely separated from frontal; two postoculars; temporals, 1+2; eye length distinctly less than distance from nostril; supralabials, 9-9, the fifth and sixth entering the orbit; infralabials, 10-11, five or six touching the first pair of chinshields which are shorter than the second (separated) pair; suture between the first labials is half as long as that between first chinshields. Scale row formula 13-13-11-11; scales, except outer row, keeled, the second row dimly keeled and the median very slightly keeled on the anterior part of the body, the keels absent on posterior part of body; two rows on each side of the median row most strongly keeled, the keels black, thus forming two narrow black lines on each side.

In life the entire body and head above and on sides is yellow green, the belly uniformly yellow; chin greenish white.

Ventrals, 169; anal divided; subcaudals, 165+ (extreme tip missing). Total length, 1925 mm.; tail 730 mm.

The specimen was taken while riding along a forest trail. The specimen was lying motionless in the dead branches of a fallen tree. I approached on horseback. Just as I was about to seize it, it whirled its head and started away, at which time I struck it with my quirt. In color it was a brilliant yellow green, in strong contrast to the immediate surroundings where the specimen was discovered.

Leptophis aeruginosus Cope

Leptophis aeruginosus Cope, Journ. Acad. Nat. Sci. Philadelphia, ser. 2, vol. 8, 1876 (1875), pp. 132-133.

Thalerophis depressirostris Oliver, Bull. Amer. Mus. Natural History, vol. 92, art. 4, 1948, pp. 203-206, (*part.*).

In his revision of the genus *Thalerophis* Oliver refers Cope's *Leptophis aeruginosus* to the synonymy of *T. depressirostris*, an action in which I concurred, after an examination of the type. The type specimen is a juvenile and now in a poor state of preservation. However, I have captured a specimen of this genus agreeing with Cope's description, at Tunnel Camp, near Peralta, Costa Rica, that convinces me that the species is distinct from *L. depressirostris* as well as from the form *T. saturatus*, which Oliver likewise has synonymized with *depressirostris*.

Description of species: K.U.M.N.H. No. 31962. Rostral much broader than high, the part visible above about one third of the length of internasals; latter scales longer than prefrontals, and distinctly longer than wide; frontal one-fifth longer than its distance from the end of the snout, somewhat bell-shaped, its greatest width equals two thirds of its length; parietals a little longer than wide, shorter than frontal; nasal divided, the anterior part longer; loreal short, its length less than one and one-half times its height; one preocular reaching upper head surface but separated from frontal; two postoculars, only the lower touching the anterior temporal; anterior temporal more than twice as long as wide, the lower secondary temporal fused to the anterior temporal. The row of scales bordering parietals and temporals subequal and regularly placed side by side; supralabials, 7-6, the fourth (or third) enters eye, infralabials, 8-8, five touching the first chinshields; second pair of chinshields one and one-half times first pair. Scale rows, 15, 15, 13, 13, lacking keels, but finely striated; apical pit on tip of scales anteriorly, the pit light in color; the diagonal arrangement of transverse lines of scales not strongly pronounced; ventrals, 148, last divided; anal divided; subcaudals, 139; total scales, 287.

Color: Rather golden brown to bronzy olive above with the median series of scales and inner edges of second row grayish yellow (whitish with epidermis removed); below bluish with a slight yellowish tinge anteriorly; chin cream-white; a black band from eye to jaw angle; most of rostral almost pure white; upper labials, except upper edges, bluish white. The bluish color of venter covers the first scale row also.

Remarks: The type of *aeruginosus* seemingly differs from "*saturatus*" in having a quadrangular loreal, a series of specialized scales behind parietals, a median light line, the absence of keels on the body, and seemingly, somewhat different proportions in head scales.

My specimen differs from the type in having the second and third supralabials, and the fifth and sixth, fused on each side, and on the left side the second, third, and fourth are fused; the last two or three infralabials are fused to form an elongate scale.

The type has 146 ventrals and 142 subcaudals, a total of 288.

Dryadophis melanolomus alternatus (Bocourt)

Coryphodon alternatus Bocourt, Bull. Soc. Philom., ser. 7, vol. 8, 1884, pp. 133-142; Mission Scientifique au Mexique et dans l'Amérique Centrale; Études sur les Reptiles, livr. 11, 1888, pl. 45, figs. 3a-e.

Dryadophis melanolomus alternatus Taylor, Univ. Kansas Sci. Bull., vol. 34, pt. 1, no. 1, Oct. 1, 1951, pp. 87-88.

A diminutive specimen, K.U.M.N.H. No. 31959, which I collected at Tenorio, Guanacaste, gives satisfactory evidence that the name *alternatus* applies to this from and is aptly named, for the specimen agrees with Bocourt's figure (*loc. cit.*) in which the quadrangular dorsal blotch alternates with a lateral quadrangular series, the blotches separated by narrow lighter marks of dirty ivory. Top of head brownish black, the edges of the head scales light tan; labials gray ivory, each labial with black spot; a very narrow light line behind parietal; large dark nuchal spot nearly divided mesially; infralabials and scales of chin gray-black, each scale with an ivory spot; the anterior ventrals with paired spots.

Besides this young specimen six adults were taken. In all the scale formula is 17, 17, 15, 15; anal divided. Two specimens examined have 23 maxillary teeth. In general all agree with the conformation of head scales indicated by Bocourt. They are listed in the following table of data.

Data on *Dryadophis melanolomus alternatus*

Number	*Sex*	*Locality*	*Ventrals*	*Sub-caudals*	*Supra-labials*	*Infra-labials*	*Temporals*
30988	♀	Bataan	185	95+	9–9	10–10	2+2
30992	♂	Turrialba	176	97	9–9	9–10	$\frac{2}{1}+2$
31968	♂	Unknown	176	95	9–9	10–10	2+2
30991	♂	Turrialba	172	103	9–9	10–10	2+(2)+2
30989	♀	Cervantes	188	101	9–10	10–10	2+2
30990	♀	Cervantes	177	99	9–9	10–10	2+2
31959	juv.	Tenorio	187	104	9–9	10–10	2+2

Dryadophis sanguiventris sp. nov.

Type: K.U.M.N.H. No. 31978 ♀; collected, Esquinas Forest Reserve, Las Esquinas, (between Palmar and Golfito), Puntarenas Province, Costa Rica, Sept. 3, 1952 by Edward H. Taylor.

Paratypes: R.C.T. Nos. 1437, 1438, Los Diamantes near Guápiles, elevation 245 meters. Richard C. Taylor collector.

Diagnosis: A member of the *alternatus* group of the genus with dorsal coloration occupying outer, turned up, one fifth of ventrals; remaining part of ventral surface of body red to magenta or nearly orange red; ventrals somewhat angulate. Labials largely red; no distinct dark line on side of head; chin mottled gray and pink.

Description of type: Rostral broader than high, narrowly visible from above; internasals two thirds as long as prefrontals, which are much wider than long, forming an acute angle laterally; rostral longer than wide, its length equal to its distance from tip of snout, shorter than parietals, whose length equals their distance from the suture between prefrontal and internasal; parietals angular posteriorly; nasal divided; loreal slender, elongate, twice as long as high; one preocular reaching upper surface of head but separated from frontal; two small postoculars; temporals, $2+2+2—2+\frac{2}{1}$; supralabials, 9-9, the fourth, fifth, and sixth entering orbit; infralabials, 11-12, six touching first chinshields, which are nearly a half shorter than second pair; scale formula, 17, 17, 15, 15; scales smooth with apical pits; ventrals, 183, subcaudals, 93, anal divided. Maxillary teeth, 20.

Color: In life, olive above, the color extending over body and tail and covering upturned ends of ventrals on each side; a gray lateral stripe on part of the fourth and fifth lateral scale rows, growing obsolete on posterior fourth of body, bordered above and below by slightly darker borders; a wider gray stripe beginning on the neck continues to near base of tail, likewise bordered by darker edges, the intervening rows between gray stripes form an olive stripe fading out posteriorly. Head brown olive, the supralabials with olive shading, above with reddish spots. Infralabials, chin, and throat with numerous pink areas outlined by brownish gray. Remainder of venter red to magenta, but fading to ivory on the under side of tail.

In preservation the red and pink has faded leaving the venter immaculate cream-white.

Measurement of type in mm.: Length, total, 1070; tail length, 288; tail length in total length, 3.71.

Variation: Ventral and subcaudal counts of the male paratypes (R.C.T. 1437, 1438) are respectively 180, 182; 96, 97; No. 1437 has a single anal plate (anomalous). The color in life is actually more red than pink but the red fades quickly in preservative to a pink before it finally disappears, leaving the color cream, then later nearly white.

Remarks: Stuart* who studied this genus considered the Costa Rican material of this genus available to him as belonging to *Dryadophis melanolomus alternatus.* He lists 16 specimens from Costa Rica and gives the following specific localities Boruca, Gúapiles, Irazú, Monte Redondo, Navarro, San José, and Talamanca. Since he does not mention the red-bellied form I presume that his material did not contain this form, or if so the red having faded in preservative, he did not recognize it.

Following Stuart the two paratypes specimens were first placed in the subspecies *melanolomis alternatus* despite obvious differences. The venter is without scattered pigment and there is no indication of a zigzag line under the tail. The scales have lost their outer epidermis and the lateral grayish stripes can be discerned only with difficulty. Stuart has noted what he designates incipient speciation in *alternatus,* and at first recognized a form in Panamá. The form described here is presumably not Stuart's *melanolomus gaigei.*

The presence of the presumed typical form of *alternatus* on both the Caribbean and Pacific Coasts as well as in the central plateau region leads me to believe that this corresponds to the Costa Rican material examined by Stuart.

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* Occ. Papers Mus. Zool. Univ. Michigan, No. 254, Feb. 9, 1933, pp. 1-10, and Misc. Publ. Mus. Zool. Univ. Michigan, No. 49, Mar. 19, 1951, pp. 1-106.

The presence of *sanguiventris* on both coasts suggests that this latter form may be a lowland form.

This species is well known to the people of Costa Rica under the name *culebra sangre.* On the other hand *alternatus* is usually identified as *savanera* along with two or three other species. (It is also true that *culebra sangre* may be applied to the young of *Clelia clelia clelia,* and not impossibly other snakes as well.) I question that this form bears a subspecific relationship to *alternatus,* since the two forms occur together on the east as well as the west coast. None of the specimens suggest that there is intergradation. In consequence I am considering this form tentatively as of species rank in spite of obvious similarity of many structural characters.

Drymobius margaritiferus margaritiferus (Schlegel)

Herpetodryas margaritiferus Schlegel, Essai sur la physionomie des Serpens, 1837, p. 185 (type locality, "Nouvelle Orleans" *ex errore.* Designated Córdoba, Veracruz, Mexico by Smith and Taylor).

Drymobius margaritiferus margaritiferus Taylor, Univ. Kansas Sci. Bull., vol. 34, pt. 1, no. 1, Oct. 1, 1951, p. 89.

Seven specimens of this species were taken, all from the farm of the Inter-American Institute of Agriculture at Turrialba, except K.U.M.N.H. No. 31967, taken at La Suiza, Costa Rica, near Turrialba.

In two of the specimens, Nos. 31003-04, only the fourth and fifth labials enter the orbit; in the others the fourth also enters. The color characters are the same in all. The keeling on the scales appears on all except the two outer rows, but in males the second row is keeled and even the outer row has keels near the vent. Small apical pits are present on scales of the several median series on the anterior part of the body, growing obscure or obsolete more posteriorly.

Table of data for *Drymobius m. margaritiferus*

No.	*Age or Sex*	*Supralabial*	*Infralabials*	*Ventrals*	*Subcaudals*	*Scale formula*
31000	yg	9–9	10–10	140	*	17–17–15
31001	♀		10–10	147	*	17–17–15
31002	♀	9–9	10–10	147	111	17–17–15
31003	♂	9–9	10–10	148	*	17–17–15
31004	♂	9–9	10–10	145	*	17–17–15
31005	♀	9–9	10–9	143½	*	17–17–15
31007	♀	9–9	10–10	144	*	17–17–15

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* Tail defective.

Drymobius rhombifer (Günther)

Fig. 11

Coryphodon rhombifer Günther, Proc. Zool. Soc. London, 1860, p. 236 (type locality, Esmeraldas, Ecuador).

Drymobius rhombifer Cope, Proc. Amer. Philos. Soc., vol. 31, Dec. 23, 1893, p. 344 (Palmar, Costa Rica).

Drymobius rhombifer Taylor, Univ. Kansas Sci. Bull., vol. 34, pt. 1, no. 1, Oct. 1, 1951, pp. 89-90.

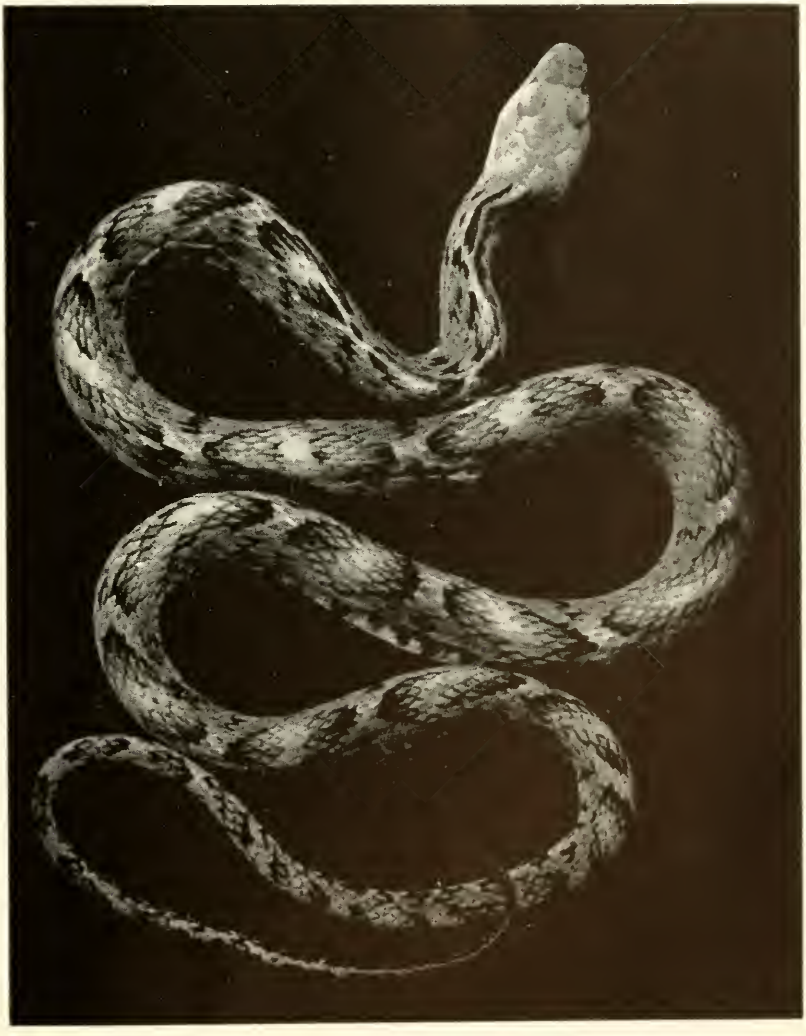

Fig. 11. *Drymobius rhombifer* (Günther). K.U.M.N.H. No. 31976; Golfito, Puntarenas Prov., Costa Rica. (Reduced somewhat. Actual total length, 980 mm.)

One specimen of this snake was taken at Golfito in heavy forest in the low mountains at an elevation of approximately 200 ft. It is a male, and the following characters obtain: Scale formula (21-19 on head), 17-17-15; the scales, except four outer rows anteriorly, and outer row throughout except in region of vent, with heavy keels, and a pair of "apical pits." The pits do not continue on outer row nor do they extend onto the tail. Ventrals, 145; subcaudals, 96; anal divided; supralabials, 9-9, the fourth, fifth, and sixth entering orbit; infralabials, 9-9, five touching first chinshield; one preocular, two postoculars; maxillary teeth, 32, increasing in size posteriorly without a diastema. Color of body typically gray and black, the head rather grayish on top and sides, with some small black flecks; chin, throat, and belly immaculate on anterior half of body, latter part of body with some darker pigment, becoming denser on the tail. The darker blotches on back are somewhat indefinite with a gray center; the whole blotch separated from the next in series by somewhat darker gray color; on neck there is a median gray line for some distance. Toward the tip of the tail the black color is arranged in three lines, the outer ones continuous, the median broken.

"The snake was first observed at some distance from us running rapidly over a fairly clear forest floor, evidently having discovered our presence from a distance. Finally it disappeared behind a large tree trunk. Baker and I ran to the tree but at first no snake could be discovered and we finally concluded that hidden by the trunk the snake had escaped by keeping the trunk behind and going in the opposite direction. Later we returned past the tree and discovered the snake in an overlooked crevasse in the trunk at a point about three feet from the ground." (From field notes.)

Drymobius chloroticus (Cope)

Dendrophidium chloroticum (Cope), Proc. Amer. Philos. Soc., vol. 23, 1886, p. 278 (type locality, Guatemala).

Drymobius chloroticus Taylor, Univ. Kansas Sci. Bull., vol. 34, pt. 1, no. 1, Oct. 1, 1951, pp. 90-91.

One specimen, K.U.M.N.H. No. 31969, was taken at Cinchona, Volcán Poás, Costa Rica. The coloration is typical. The ventral count is 183; the subcaudal count is incomplete the tail being defective. Apical pits are present on scales.

This species has a wide range, extending as far north as San Luis Potosí in Mexico.

Drymobius melanotropis (Cope)

Dendrophidium melanotropis Cope, Journ. Acad. Nat. Sci. Philadelphia, ser. 2, vol. 8, 1876 (1875), p. 134, pl. 26, fig. 1, (type locality, Costa Rica).
Drymobius melanotropis Taylor, Univ. Kansas Sci. Bull., vol. 34, pt. 1, no. 1, Oct. 1, 1951, p. 91.

A small specimen of this species, K.U.M.N.H. No. 31973, was taken at Estrella, Costa Rica, by Sr. Marco Tulio Pacheco. The specimen is discolored by preservatives but is otherwise in good condition.

The following scale characters obtain: ventrals, 149; subcaudals, 94; anal divided; scale formula, 17, 17, 15; supralabials, 9-9, the fifth and sixth entering orbit, the fourth very narrowly excluded; eighth greatly elongate; infralabials, 9-10, five touching first chinshields.

The lower parts of the supralabials, chin, venter, and subcaudal area is yellowish white in preservative, the dorsal coloration of body occupying the end of ventrals.

Dendrophidion percarinatus (Cope)

Fig. 12.

Drymobius percarinatus Cope, Proc. Amer. Philos. Soc., vol. 31, Dec. 23, 1893, pp. 344-345 (type locality, Boruca and Buenos Aires, Costa Rica. The adult specimen from Boruca is regarded as the type and the type locality is here restricted to Boruca).
Dendrophidion percarinatus Smith, Proc. Biol. Soc. Washington, vol. 54, July 31, 1941, pp. 73-76.
Dendrophidion dendrophis Taylor, Univ. Kansas Sci. Bull., vol. 34, pt. 1, no. 1, Oct. 1, 1951, p. 92.

Three Costa Rican specimens are referred to this species. They are, K.U.M.N.H. No. 30997, Los Diamantes, Limón Prov.; No. 30998, Bataan, Limón Prov.; No. 31948, Golfito, Puntarenas Prov. In listing the Costa Rican snakes in my review (Taylor *loc. cit.*) I overlooked a paper dealing with the genus *Dendrophidion* by Dr. Hobart M. Smith who points out that the name *dendrophis* is not available for any Central American *Dendrophidion,* and suggests that specimens so identified having a divided anal scale, should be called *Dendrophidion percarinatus* (Cope). Hence this name will replace *D. dendrophis* in the Costa Rican fauna.

No specimen of this genus was available to me when I compiled data for the review of the Snakes (Taylor *loc. cit.*). I submit the following general description of the species:

Rostral rather narrowly visible above; internasals as long as wide; prefrontals wider than long; frontal a third longer than wide, its length greater than its distance from tip of snout; supraoculars more than twice as wide as long, narrower than frontal; parietals

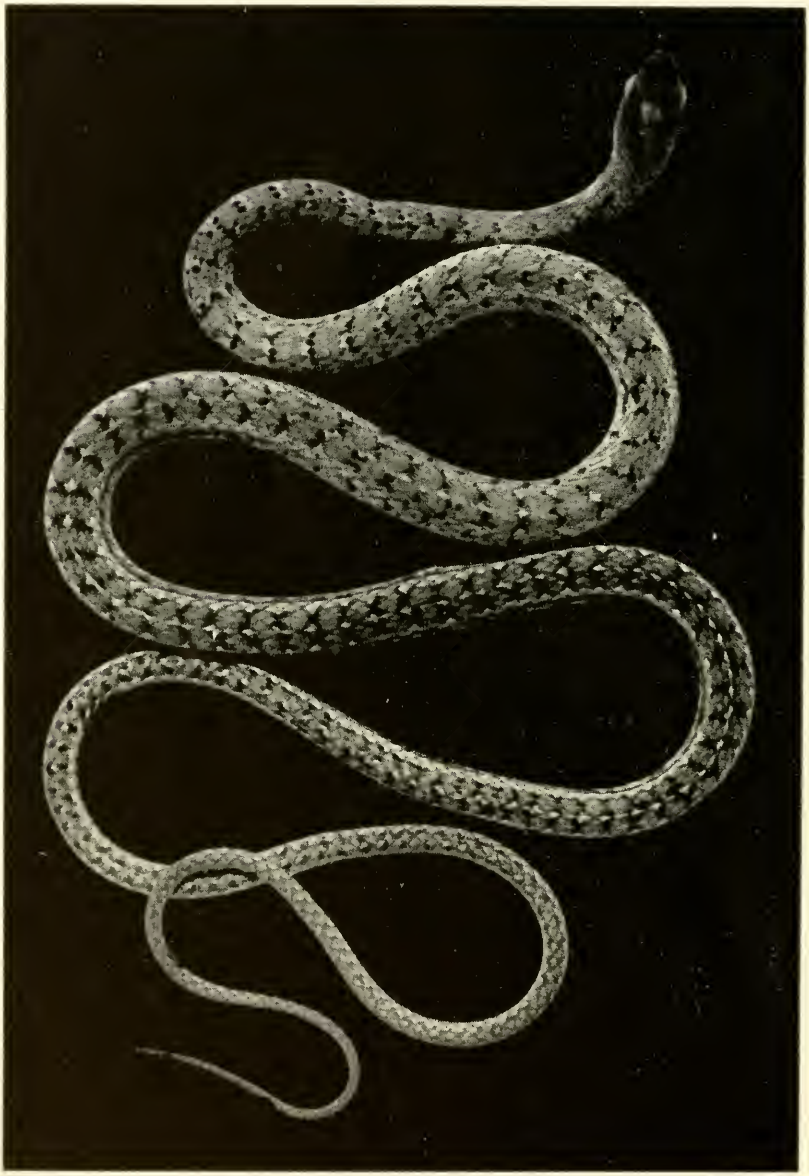

FIG. 12. *Dendrophidion percarinatus* (Cope). K.U.M.N.H. No. 31948; Palmar, Puntarenas Prov., Costa Rica. (Actual total length, 840 mm.)

a fourth longer than wide, their length equal to their distance from about middle of prefrontal; nasal divided, the posterior part the higher; loreal a little less than twice as long as high; one large preocular separated from frontal; two postoculars, upper the larger;

temporals, 2 + 2 + 3; supralabials, 9-9, the fourth, fifth, and sixth border orbit; infralabials, 10-10, five bordering the first chinshields, which are a little shorter than the second pair; latter scales separated by smaller scales. Scale formula, (21-17)-17-15; the scales of all but the outer row strongly keeled, however, anteriorly the first four rows lack keels on the neck and the second row is keeled on latter half of body. Most of the body scales, as well as those on tail, with apical pits. Ventral and subcaudal counts are as follows for the three specimens: No. 30997: ventrals, 164; subcaudals ?; anals 2. No. 30998: ventrals, 151½; subcaudals, 154; anals, 2. No. 31948, ventrals, 159; subcaudals, 156; anals, 2.

The characteristic color pattern is indicated by the figure given here (Fig. 12). Variation in caudal counts are from 142 to 163.

Smith gives Tilarán, Guanacaste, Costa Rica as a locality for this species. The range is from Honduras to Panamá.

Dendrophidion vinitor Smith

Dendrophidion vinitor Smith, Proc. Biol. Soc. Washington, vol. 54, July 31, 1951, pp. 73-76 (type locality, Piedras Negras, Guatemala).

This species was omitted from my "Review of the Snakes of Costa Rica." It may be diagnosed by the following characters:

Rostral broader than high, the portion visible above a third the length of internasals; frontal pentagonal, longer than its distance from tip of snout; nasal completely divided; loreal a little longer than high; one large preocular not reaching frontal; two postoculars, upper largest; two anterior temporals; supralabials nine, the third, fourth, and fifth bordering orbit; diameter of eye three times its distance from labial border; infralabials nine, five touching anterior chinshields, which are larger, but their length is equal to posterior pair.

Scale formula: 17-17-15, strongly keeled except on outer row; ventrals, 151-169; subcaudals, 115-126, length 1453 mm., body 948 mm. (tail incomplete).

Color in life: (taken from field notes). Dorsal surface of head brownish gray with a slightly reddish tinge, the sutures darker; upper parts of four anterior supralabials with a reddish tinge; dorsal head color extending laterally in temporal region onto upper edges of two postorbital supralabials, covering the last entirely; this color bordered below by dark brown, mixed with dull, brownish brick-red; lower parts of 7th and 8th infralabials all of 5th and 6th, and and lower parts of 3rd and 4th pure white; 59 bands on body, 54 on tail; band on neck covering one scale-length, brownish gray laterally, yellow dorsally; size of yellow dorsal area, in the light bands, decreasing posteriorly, light bands margined anteriorly or posteriorly (or both) by narrow, irregular areas of black; light bands becoming practically indistinguishable on posterior part of body; tail bands and those on posterior part of body black; black borders of light bands interspersed with or themselves bordered by brick-red, this color especially prominent medially; central ground color between bands, browish gray anteriorly, becoming light brown tinged with red on middle and posterior part of body; tail with a lateral stripe of dark brownish black, interspersed with brick-red, involving edges of subcaudals and lower half of outer scale rows; medially it is bordered by a light line two half scale-rows wide; these two light stripes enclose two series of transverse, short dark spots (less than one scale-length), separated from each other by a series of vague light spots; gular region white; belly yellow; subcaudal surface yellow, lighter posteriorly.

Pseustes poecilonotus chrysobronchus (Cope)

Spilotes chrysobronchus Cope, Journ. Acad. Nat. Sci. Philadelphia, ser. 2, vol. 8, 1876 (1875), p. 136, pl. 28, figs. 11a, 11b (type locality, southeastern Costa Rica, by inference).

Pseustes poecilonotus chrysobronchus Taylor, Univ. Kansas Sci. Bull., vol. 34, pt. 1, no. 1, Oct. 1, 1951, pp. 92-94 (*part.*).

A specimen of this species was taken at Turrialba, K.U.M.N.H. No. 8738. The following characters obtain: a single preocular separated from frontal; prefrontal narrowed laterally, wider than long, not reaching frontal; frontal equals its distance from tip of snout; parietals as long as wide or slightly longer; nasal divided; temporals, $2 + 2$, $(\frac{2}{1} + 2)$; supralabials, 9-9, the fourth, fifth, and sixth bordering orbit; infralabials, 12-12, seven touching the first chinshields; two touching second; scale formula: 21,23,25,17,15,(14); most scales except outer row with well-defined apical pits, and anteriorly the three median rows, more posteriorly, all rows except outer, with keels, three median rows most heavily keeled; seven labials touching first chinshields. The ventrals are 206; anal single; subcaudals, 147.

The head and neck are coal black except for some white on outer one or two rows. Chin, throat, and anterior part of venter cream white. The pigment begins to encroach on the ventrals at about no. 45 and soon the undersurface is uniformly black on venter and subcaudal region save for an occasional cream spot. Outer part of anterior ventrals with discrete black spots.

A specimen of this species was inadvertently associated with *Pseustes shropshirei* in my review of the Costa Rican snakes (Taylor *loc. cit.*).

This specimen has the scale formula, 21,23,25,13(15); the ventrals are 214, the tip of the tail missing.

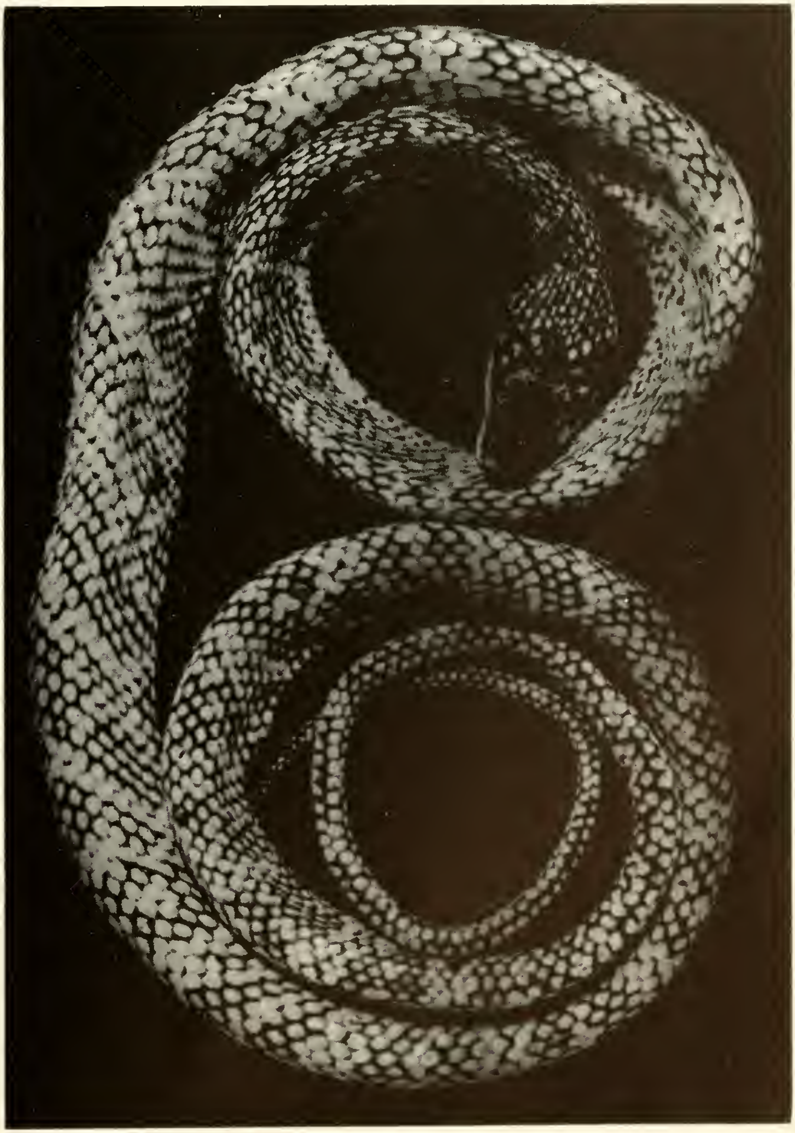

FIG. 13. *Pseustes shropshirei* (Barbour and Amaral). K.U.M.N.H. No. 25173; Costa Rica. (Actual total length, 1,543 mm.)

Pseustes shropshirei (Barbour and Amaral)

Fig. 13

Phrynonax shrophirei Barbour and Amaral, Occ. Papers Boston Soc. Nat. Hist., vol. 5, Sept. 12, 1924, p. 131 (type locality, vicinity of Gatun, Canal Zone, Panamá).

Pseustes shropshirei Taylor, Univ. Kansas Sci. Bull., vol. 34, pt. 1, no. 1, Oct. 1, 1951, p. 94 (*part.*, not R.C.T. 682).

Pseustes poecilonotus chrysobronchus (*part.*) Taylor, *op. cit.* p. 93. (Specimen described from Turrialba [K.U.M.N.H. No. 25173].)

A specimen of the above species taken 5 km. SE of Turrialba was in advertently referred to *P. p. chrysobronchus* in Taylor (*loc. cit.*). A figure of this specimen showing the light phase of color, is presented here.

Chironius grandisquamis (Peters)

Spilotes grandisquamis Peters, Monatsb. Akad. Wiss. Berlin, 1868, pp. 451-452 (type locality, Costa Rica).

Chironius grandisquamis Taylor, Univ. Kansas Sci. Bull., vol. 34, pt. 1, no. 1, Oct. 1, 1951, pp. 96-97.

Only a single male specimen, (K.U.M.N.H. No. 34900,) of this species was taken. It was moving about on the forest floor and took refuge in a rotting hollow log from where it was dislodged with considerable difficulty. The following characters obtain: ventrals, 162, subcaudals, 144, scale formula: 10,10,8,8; the two median rows heavily keeled, the keels not quite as high as the midridge of body, the outer row is smooth throughout, irregular; second row larger than first and near middle of body a few faint keels can be seen; the third row has faint keels along the middle of body. The fourth row is smooth. Single apical pits can be detected on many of the nuchal scales; supralabials, 9-9, fourth, fifth, and sixth bordering orbit; infralabials, 10-10, five touching chinshields.

The anterior color is brownish black with some lighter marks either crossing back or indicated on skin between scales, with an occasional cream edge on a scale. A few black spots along outer scale row and on outer part of ventrals. The chin and ventrals on the anterior part of the body are cream-white but at the 106th ventral, the black from the outer ends of the ventrals begins to encroach on the scales and in the latter two fifths of the body the ventrals are black with only occasional white flecks; the subcaudal region is black with white spots or flecks along the inner edges of the subcaudals. Dorsally the latter two fifths of the body is blackish with the transverse marks indicated by an occasional light area on a scale.

Chironius melas (Cope)

Herpetodryas melas Cope, Proc. Amer. Philos. Soc., vol. 23, 1886, p. 278 (type locality, Nicaragua).

Chironius melas Taylor, Univ. Kansas. Sci. Bull., vol. 34, pt. 1, No. 1, Oct. 1, 1951, p. 97.

I have not examined the type of this species and do not know its sex. I have suspected that the specimen may be a female with the keeling obsolete and in consequence I am referring to the species two Costa Rican *Chironius*, one K.U.M.N.H. No. 34892 from 20 miles WSW of San Isidro del General, and No. 34895 from Estrella, Limón Province.

The specimen from San Isidro del General is shiny black above on head and body, with the anterior venter, throat, and chin, as well as the lower half of the supralabials cream-white. The posterior half of body, and tail are deep black. The loreal is nearly square and the preocular is divided, the upper part widely separated from the frontal. The temporals are 1 + 1 + 1, the anterior small. The ventrals are 158; subcaudals, 142; the anal divided. The supralabials are 9-9, the fourth, fifth, and sixth enter orbit; infralabials, 10-10, the first five touch the first chinshields; there are three touching the second chinshields. The scale formula is 10-10-8-8, with the fifth median rows very strongly keeled, the first and fourth rows smooth, the second and third with lighter keels.

My specimen from Estrella is larger than the preceding but it agrees in the characteristics of color, scale formula, and the keeling of the scales. However, the preocular is not divided, the temporals are 1 + 2, the ventrals are 164, the subcaudals, 143; the number of labials and their relationships are the same. I can discern no apical pits in these specimens.

Should it prove that the males of *Chironius melas* are unkeeled it will be necessary to separate these specimens from *melas*.

Drymarchon corais melanurus (Duméril, Bibron, and Duméril)

Spilotes melanurus Duméril, Bibron and Duméril, Erpétologie Générale . . . vol. 7, pt. 1, 1854, pp. 224-225 (type locality, "Mexico," restricted to Chichen Itzá, Yucatán).

Drymarchon corais melanurus Taylor, Univ. Kansas Sci. Bull., vol. 34, pt. 1, no. 1, Oct. 1, 1951, pp. 99-100.

A specimen, K.U.M.N.H. No. 34877, in the collection, was taken by John Baker, at Turrialba. The length of the parietals is equal to their distance from the prefrontal-internasal suture. The specimen agrees in other discernible characters with the one described by Taylor (*loc. cit.*).

The width of the head is 56 mm.; the length 72 mm.; the body is mutilated. Head brown; the labial sutures, except between first and second supralabials, and the first three infralabials, are heavily outlined in black and a strong diagonal black stripe is present on the sides of the neck.

Leimadophis taeniurus juvenilis Dunn

Leimadophis taeniurus juvenilis Dunn, Copeia, 1937, no. 4, p. 213, (type locality, San José, Costa Rica); Taylor, Univ. Kansas Sci. Bull., vol. 34, pt. 1, no. 1, Oct. 1, 1951, p. 102.

K.U.M.N.H. Nos. 31899, 31900 from Cinchona and No. 31901, Guadalupe, San José, Leslie Holdridge, coll., are in the collection. No. 31899 is an adult female, containing eight or nine eggs.

The ventrals of the adult specimen are 142, subcaudals, 60; No. 31901, ventrals 144, subcaudals, 59; No. 31900, ventrals, 144, subcaudals, 51. The anal is divided in all.

Pliocercus arubricus sp. nov.

Fig. 14

Type: K.U.M.N.H. No. 31943; Isla Bonita, southeastern slope Volcán Poás, elevation approximately 5,500 feet; collected July 19, 1952 by Edward H. Taylor.

Diagnosis: A species of *Pliocercus* lacking red coloration. Black, with lighter bands that dorsally are light lavender with black spots on each scale, gradually becoming white on side and venter, the bands three to three and a half scales wide on body and tail; intervening black areas more than twice as wide on body mesially, covering anteriorly five or five and a half scale-rows, posteriorly on body six to seven and a half rows; on tail the black covers ten to thirteen scales and a space three to four times greater than light bands. Two preoculars; two postoculars, the fourth and fifth labials entering orbit; temporals, 1+1, separated from orbit. Scale formula, 21-19, 17, 17.

Description of type: Rostral much broader than high, visible above as a line; internasals moderate in size, not especially small, their width a little greater than their length; their common suture equals half of the suture between prefrontals; latter scales about as long as wide, narrowed laterally; frontal hexagonal, the sides parallel, the length greater than distance to the tip of the snout, generally shield-shaped; parietals much longer than wide, their length equal to their distance from internasals; nasal divided or at least partially divided; loreal large, somewhat rhomboidal; two preoculars, the upper large, widened near top, separated from frontal; lower

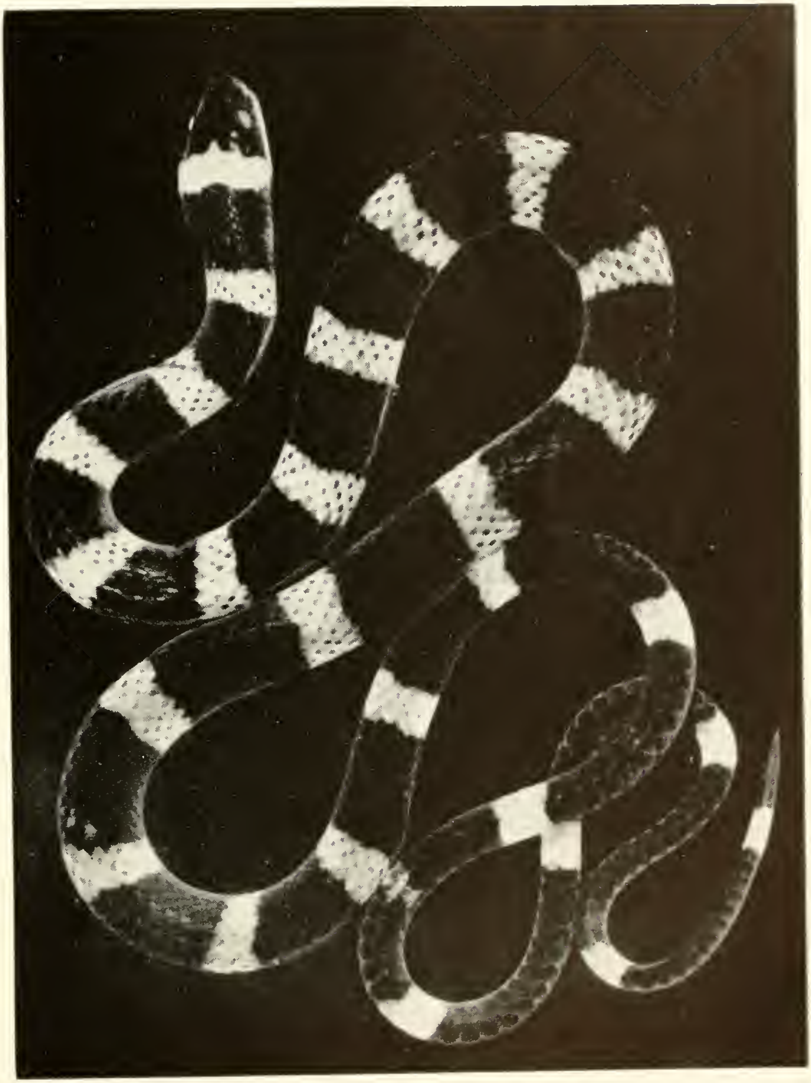

FIG. 14. *Pliocercus arubricus* sp. nov. Type. K.U.M.N.H. No. 31943; Isla Bonita (Cinchona), Volcán Poás, Costa Rica. (Actual total length, 580 mm.)

preocular wedged between the third and fourth labials; two postoculars, the upper the larger; one anterior temporal, narrow, not entering eye; one secondary temporal; upper labials, 8-8; the fourth and fifth entering orbit; supralabials in the following ascending order of size: 1,2,3,4,5,6,8,7; infralabials, 9-9, five in contact with first chinshields; second pair of chinshields a little longer and narrower than first pair; mental triangular.

Scales smooth, in 21-19 rows on neck, 17 on body, 17 in front of vent; no apical pits; ventrals, 139; anal divided; subcaudals, paired, 112.

Color: Generally intense black with series of lighter bands. On head cream spots on anterior supralabial, mental, and rostral; a clear cream band on head covering latter half of parietals and connecting with the white on chin; first black spot begins just back of the parietals and is partially broken ventrally; anterior infralabials black; 18½ black areas on body and neck, 8½ on tail; 26 light bands. These becoming white on sides and on venter covering three to three and one half scale-lengths; the black bands are variable, usually covering five scale-lengths anteriorly; six to seven and one half posteriorly on body; on tail from ten to thirteen.

Measurements in mm.: Total length, 580; tail length, 235; width of head, 9.8; length of head, 17; tail in total length, 2.46 times.

Remarks: This form, lacking red coloration seemingly represents different stock from *dimidiatus, annellatus* or *euryzonus.* It is surprising that the markings on the head should mimic those of *annellatus* to such a degree.

Owing to the loss of the terminal part of the tail, comparison of the relative tail-body length cannot be made, nor can comparison be made on the ventral counts since one is male, the other a female. The number of 139 ♂ for ventrals is very nearly the same 137 ♀ for *annellatus.* The frontal is somewhat longer and the number of light bands on the body is smaller. There is rather close conformity between the two on the general characters of the head scales.*

Rhadinaea decorata decorata (Günther)

Coronella decorata Günther, Catalogue of the colubrine snakes in the collection of the British Museum, 1858, pp. 35-36 (type locality, Potrero Viejo, Veracruz, Mexico [restricted]).

Rhadinaea decorata decorata Taylor, Univ. Kansas Sci. Bull., vol. 34, pt. 1, no. 1, Oct. 1, 1951, pp. 113-116, pl. 11.

Specimens of this species in the collection are K.U.M.N.H. Nos. 30960, Turrialba, 31940, Limón, and 31942, Turrialba, 31941, Tenorio. The first two agree with the specimen described and figured by me. (*loc. cit.*).

Scale data on *Rhadinaea decorata decorata* (Günther)

Number	30960	31940	31942
Sex	♂	♂	♂
Ventrals	117	125	124
Subcaudals	58+	68+	82+
Maxillary teeth	20	20	19

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* The figure 4 of the type of *Pliocercus annellatus* shows only a single preocular; actually the small lower is present but not indicated in the sketch.

A specimen K.U.M.N.H. No. 31941 from Tenorio, Guanacaste, Costa Rica has practically the same head markings as the preceding save that the dorsolateral line is on the edges of the fifth and sixth scale rows and is limited below by a fine black line. The dorsal scales (five and two half rows), are nearly uniform brown. The dots on the outer edges of ventrals are small. The ventrals are 125, the subcaudals 100. The ocelli on the head are the same, the third one beginning the lateral line. The labials are white, bordered by a dark line, and the upper part of the preocular has a lighter spot.

In life the specimen was dark wood-brown above, the dorsolateral line cream, the head and neck spots having a brownish tinge. The lips, chin, neck, and throat were white, the venter was pink, the outer scale row also having this color.

Rhadinaea serperaster Cope

Fig. 15

Rhadinaea serperaster Cope, Proc. Acad. Nat. Sci. Philadelphia, Oct. 24, 1871, pp. 212-213 (type locality "near San José, Costa Rica").

Rhadinaea serperastra Cope, Journ. Acad. Nat. Sci. Philadelphia, ser. 2, vol. 8, 1876 (1875), p. 140; Taylor, Univ. Kansas Sci. Bull., vol. 34, pt. 1, no. 1, Oct. 1, 1951, pp. 112-113.

In my review of the Snakes of Costa Rica I followed the second spelling of Cope (see above) which I presumed was a correction of the first name. However, the first spelling, *serperaster* * I believe, must stand, despite the fact that Cope used the second spelling also in a later paper (U. S. Nat. Mus. Bull. no. 32, 1887, p. 80) and may have intended to show the first usage an error. However, I fail to find mention of this fact in print.

Two specimens of this strongly striped species are in the collection. One, K.U.M.N.H. No. 30948 ♂, was taken from under a stone at the edge of the road on Volcán Barba, elevation approx. 6,000 feet, July 15, 1951; and a second specimen No. 31953 ♀, was found in moss on the southeast slope of Volcán Poás at Cinchona, approximately 5,600 feet, July 24, 1952, while searching for salamanders.

The ventral-subcaudal counts are, respectively, 166½, 69; 172, 72; scale formula, 19-19-19.

The light area across the frontal forms two indistinct light spots and the light lines on body are widened at their terminations on the neck leaving a suggestion of six spots. Head generally black

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* These words in an available lexicon have the following meanings:
Serperaster—tri = hanger on.
Serperastra—orum (n. pl.) = knee splints; severe officers.

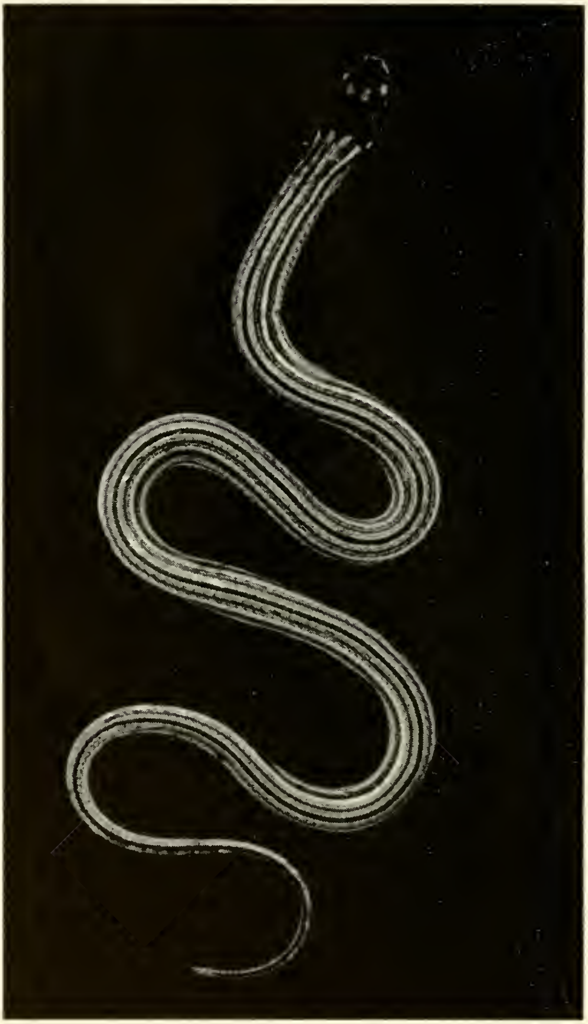

FIG. 15. *Rhadinaea serperaster* Cope. K.U.M.N.H. No. 31953; Cinchona, Volcán Poás, Costa Rica. (About natural size; young specimen.)

with white spots on the upper labials. Chin white with some darker flecks on the lower labials. The general color pattern agrees with that of the type. The anterior chinshields of these two specimens are much larger and longer than second pair. Maxillary teeth 15 + 2 without distinct diastema or groove.

The younger specimen has the first five subcaudals undivided. The loreal is rectangular rather than square.

Rhadinaea decipiens rubricollis subsp. nov.

Type: K.U.M.N.H. No. 31956. Collected, June 23, 1952 at Cinchona, Volcán Poás, Costa Rica. Elevation approximately 5500 feet, Edward H. Taylor, collector.

Diagnosis: A black snake with an indistinct white dotted line on outer scale row; a narrow red collar on neck extending over one scale row and back part of parietals, widening in temporal region and narrowly connecting with pinkish ventral coloration of chin; head reddish brown, the brown color not bordered by blackish posteriorly; anterior upper and lower labials lavender, partly outlined with darker pigment; chin bright pink. Scales in 17 rows; supralabials eight; infralabials nine; two pre- and two postoculars; temporals, 1 + 1 + 2; head distinct from neck; maxillary tooth series 15 or 16 with two somewhat enlarged teeth separated from the series by a short diastema. No apical pits discernible.

Description of type: Head elongate, distinct from neck; rostral more than one and one-half times as wide as high, visible above as a narrow triangle, less than half length of internasals; latter scales distinctly broader than long, their length nearly two thirds of the length of the prefrontals; latter scales wider than long; frontal one-third longer than wide, the sides slightly emarginate, its length more than a third greater than its distance from tip of snout; parietals rather slender, longer than their distance from tip of snout; supraoculars twice as long as wide; nasal divided, the two scales of nearly equal size and height (the posterior a little larger on one side); loreal about as wide as high; two preoculars, the lower small, wedged between the third and fourth labials, upper large, twice as wide as high, visible above but separated from frontal; two postoculars, upper largest, both touching the long narrow anterior temporal; temporal formula, 1 + 1 + 2; supralabials eight in the following order of size: 1,2,3,4,5,6,8,7, the fourth and fifth border orbit; nine infralabials, the first five border the first chinshields, which are shorter, but a little wider than second pair; latter in contact for three fourths of their length. Scales in about 21 rows on back of head; on body the formula is 17-17-17; the ventrals are 130, anal divided; 126 subcaudals; scales smooth without apical pits. The type, a young specimen, presumably a male, has no trace of keels on sides above vent. Diameter of eye equal to its distance from nostril.

Color: In life, body black, head reddish brown; a reddish band across back of parietals and nape, widening in temporal region. A very narrow blackish line from eye to near jaw angle, not severing completely the nuchal band; supralabials lavender, more or less dark edged; chin and infralabials pink, the mental, five anterior labials, and the first chinshields with some dark pigment; first scale row with small paper-white spots that form a dotted line; lower part of first row with black dots more or less contiguous with well-defined black spots on outer edge of ventrals; venter for four fifths of its length flesh white; remainder of body and subcaudal region bluish white.

Measurements in mm.: Snout to vent, 121; tail, 81; total length, 202; width of head, 5.1; length of head, 10; tail in total length, 2.4 times.

Remarks: This species appears to be clearly differentiated from other *Rhadinaea* of Costa Rica, except *Rhadinaea decipiens* (Günther), by the low ventral and high subcaudal count. It seemingly differs from the types of the latter species which came from Irazú (volcano?) as follows: Head distinct from neck; reddish brown, with a red band on back of head; chin reddish pink; the narrow dashed line absent from the fifth scale row; the line on outer scale row is a connected series of dots rather than a dashed line. The maxillary teeth are 17 or 18, the two posterior teeth (without grooves) a little the largest with a small distinct diastema separating them from the maxillaries; ventrals 130, are fewer and the subcaudals 125, are more numerous than in *d. decipiens,* totaling 256. (In the three types of *decipiens,* ventrals 133-151; subcaudals 110. One specimen with complete count has a total of 243.)

Rhadinaea altamontana sp. nov.

Fig. 16

Type: K.U.M.N.H. No. 30962. Collected at the edge of the Costa Rican National Forest Reserve, Pan-American Highway, Talamanca Range, Costa Rica. Elevation between 7000-8000 ft. Collected by Edward H. Taylor and Jack Reark.

Diagnosis: A *Rhadinaea* with a short, rather broad head related to *R. godmani;* head blackish with a short white line present from eye; chin and venter white. A narrow median dark line from neck to tip of tail, bordered by a broad lighter band, six scales wide, below which is another slightly darker band four scales wide but the scales on this band have lighter centers also; scales in 21 rows on neck and body throughout. Male with strong keels or knobs on lateral scales above vent.

Description of type: Rostral at least one and a half times broader than high, narrowly visible above for about one third of the width of the internasals; latter scales wider than long, their length more than half the length of the prefrontals which are wider than long; frontal longer than wide, pointed behind, its length slightly longer than its distance from tip of snout, much shorter than parietals;

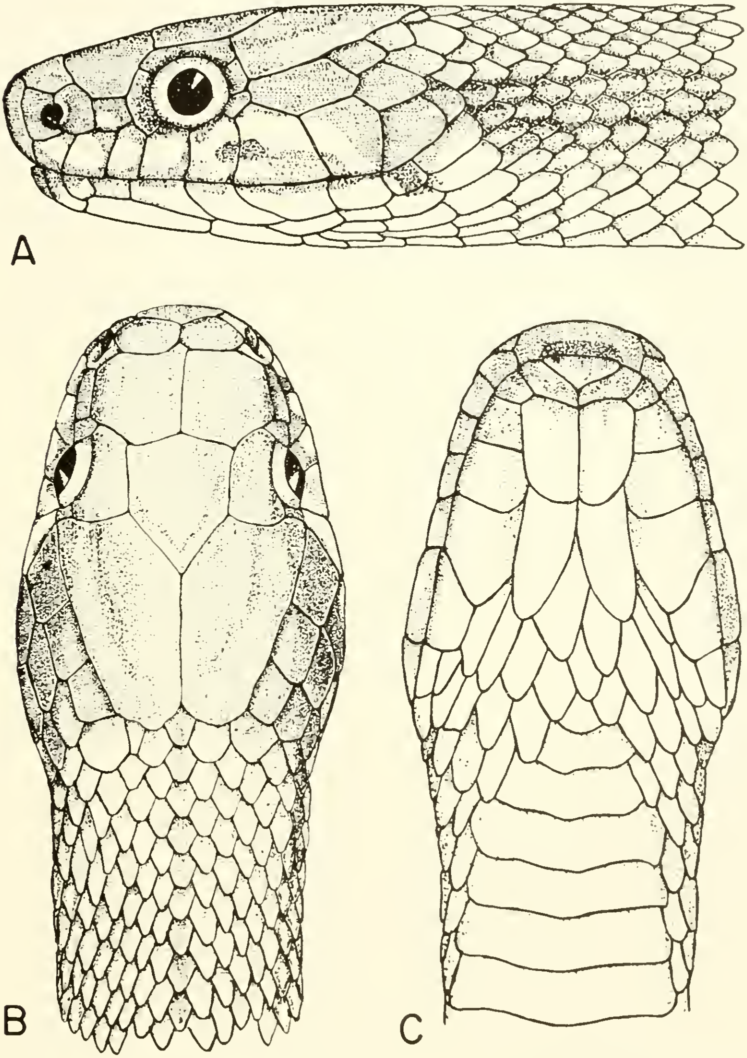

Fig. 16. *Rhadinaea altamontana* sp. nov. Type. K.U.M.N.H. No. 30962; Forest Reserve, Pan American Highway, East slope of the Talamanca Range, Costa Rica. (× 5.)

latter more than a half longer than wide, their length equalling their distance from rostral; nasal divided, the nostril cut chiefly in the anterior; the posterior nasal higher than anterior; loreal slightly longer than high; an elongate preocular twice as high as wide, widely separated from the frontal; supraoculars much longer than wide; two postoculars, upper largest, both touching anterior temporal; temporals, 1 + 2 + 3; supralabials eight, the fourth and fifth border orbit, their ascending order of size, 1,2,3,4,8,5,6,7; infralabials eight, four anterior touching the first pair of chinshields, which are as long as, but a little broader than second pair; latter separate for about half their length.

Scales about back of head 24; on neck one inch back and on body the formula is 21-21-21. Scales somewhat acuminate without apical pits. Ventrals, 170; anal divided; subcaudals, 83. The scales on sides above vent have very strong keels or knobs. The maxillary teeth are 19, increasing in size posteriorly, the last two largest but not separated by a noticeable diastema.

Color: In life, head blackish above and on sides; body brownish generally; ventral surfaces yellowish cream. First five labials with yellowish cream spots; beginning in upper part of fifth supralabial and continuing across upper part of sixth and diagonally across seventh, is a well-defined cream line terminating on the cream yellow color of chin after crossing seventh infralabial; a slightly lighter area bordering black edge of rostral, and a dim light spot on loreal; indication of a transverse lighter band following the black of the head which is limited below by a narrow indistinct extension of the black color of the head; two slightly lighter areas on parietals; a median gray-black line on median dorsal scale row extending to tip of tail; adjoining six rows brownish, the scales with lighter centers; four outer rows with lower edge of fifth forming a slightly darker band, each scale having a lighter center; outermost edge of ventrals with slight pigmentation; outer scale row largest with a more or less continuous cream stripe on outer scale row; lower labials, except sixth, more or less pigmented.

Measurements in mm.: Snout to vent, 378; tail, 152; total length, 530; width of head, 10; length of head to jaw angle, 15; tail in total length, 3.5 times.

Remarks: This specimen was taken at a higher elevation than any other snake I have found in Costa Rica. It was under a rotting log in a swampy area in an oak forest. The vegetation in the immediate vicinity was of a bog type, including very numerous small tree ferns a few feet high. I was assisted in the capture of the specimen by Mr. Jack Reark.

This seemingly is the only southern form of the genus *Rhadinaea* having 21 scale rows on the body. I regard it as related to *Rhadinaea godmani,* a rare species occurring in Guatemala.

The most obvious differences from *godmani* (based on the data of Boulenger, Günther, and Bocourt) are a very different color pattern on body, a shorter head, black in color, and the presence of strong keels or knobs on the lateral scales above vent. From other southern forms now known it may be distinguished by the presence of 21 scale rows.

Rhadinaea persimilis Dunn

Rhadinaea persimilis Dunn, Copeia, 1938, no. 4, Dec. 10, pp. 197-198 (type locality, La Loma, 1500 ft. alt., Bocas del Toro, Panamá); Taylor, Univ. Kansas Sci. Bull., vol. 34, pt. 1, no. 1, Oct. 1, 1951, pp. 112, 117.

This distinctive red-bellied species is represented by two specimens; K.U.M.N.H. No. 31938, La Lola, Limón Prov., Costa Rica, and No. 31939, Palmar, Puntarenas Prov., Costa Rica.

The specimen No. 31939 is described. Rostral barely visible above as a thin line; internasals wider than long, their length about one half length of prefrontals; latter wider than long; frontal shield-shaped, its length one and a third times greater than its distance from tip of snout, longer than wide; parietals as long as their distance from rostral; nasal divided, the anterior part lower than posterior; loreal about as high as long; one preocular more than twice as high as long; two postoculars; temporals, 1 + 1 + 2; supralabials, 8-8, the fourth and fifth bordering orbit; infralabials, 7-7, the first four bordering the first chinshields, which are separated from the mental by the first labials; first and second pairs of chinshields of nearly equal length. Scale formula, 17-17-17, the scales without apical pits; ventrals 135; anal divided; tail partly lost.

Five median scale rows brownish. A narrow cream-white line from neck onto tail along edges of fifth and sixth scale rows, edged with blackish; a strong discreet white line on edges of scales one and two continues onto tail, below which a black line of unequal thickness follows on outer scale row and edges of ventrals; lower part of supralabials cream, the line connecting with its fellow from opposite side around rostral; some indistinct marks on snout and above eyes; an ocellus on outer edge of parietal; a white spot behind jaw fused with dorsolateral white line; nuchal spot present; some black dots on tip of chin.

A very young specimen, No. 31938, was injured while digging at the base of a rotting tree. The ventral red was less intense in life and the dorsal color is brown with the scales showing lighter centers; the white lines on the body are bordered by blackish lines. The anterior part of the head is dark but there is a white line surrounding the rostral connecting with two white spots on the internasals; a pair of elongate spots on outer side of prefrontals, more or less connecting with the elongate spot above eye in supraocular; a dim line on front edge of frontal, one in outer angle of parietal, one on the temporal scales and one, the largest, at a point near jaw angle not connecting with the dorsolateral line; a small white spot on middle of neck; all light spots surrrounded by dark borders. The ventral count cannot be ascertained. There are 98 subcaudals.

Leptodeira nigrofasciata Günther

Fig. 17

Leptodira nigrofasciata Günther, Ann. Mag. Nat. Hist., ser. 4, vol. 1, 1868, p. 425 (type locality, Nicaragua); Taylor, Univ. Kansas Sci. Bull., vol. 34, pt. 1, no. 1, Oct. 1, 1951, p. 121.

A young specimen of this rare species was discovered under a rock on the airfield at Tenorio, Guanacaste, Costa Rica, Aug. 24, 1952. Since no adequate description is given in Taylor (*loc. cit.*) I append a description of this specimen (K.U.M.N.H. No. 31932).

Rostral barely visible above; internasals as long as wide, two thirds of length of prefrontals; latter a little broader than long, their sutures with the frontal forming a straight line; frontal somewhat bell-shaped, its length greater than its distance from tip of snout, longer than wide; parietals elongate, rather narrow, their length about equal to their distance from rostral; nasal divided, posterior part larger; loreal higher than long; two preoculars, the upper widened at upper level of eye, reaching frontal, the lower wedged between third and fourth labials; two postoculars, upper largest; temporals, 1+2+3, 2+2+3, there is a small scale segmented from the first temporal; supralabials eight, the fourth and fifth bordering orbit; infralabials ten, five touch first chinshields, two touch second pair; latter equal or slightly longer than first pair.

Scale formula: 19-19-17, the scales minutely striate, each bearing a pair of minute apical pits; ventrals, 169, anal divided, subcaudals 69.

Color in life: Above brownish lavender with gray-white bands; venter nearly uniform white, the subcaudal area peppered with lavender. Top of head, as far back as the end of parietals, dark, all the labials with larger or smaller areas of white peppered lightly with lavender pigment; first white band, touching edge of parietals, about four scale-rows wide; the first seven white bands complete across back, separated from each other by black areas covering nine to twelve scale rows; beyond this the eleven light bands break mesially

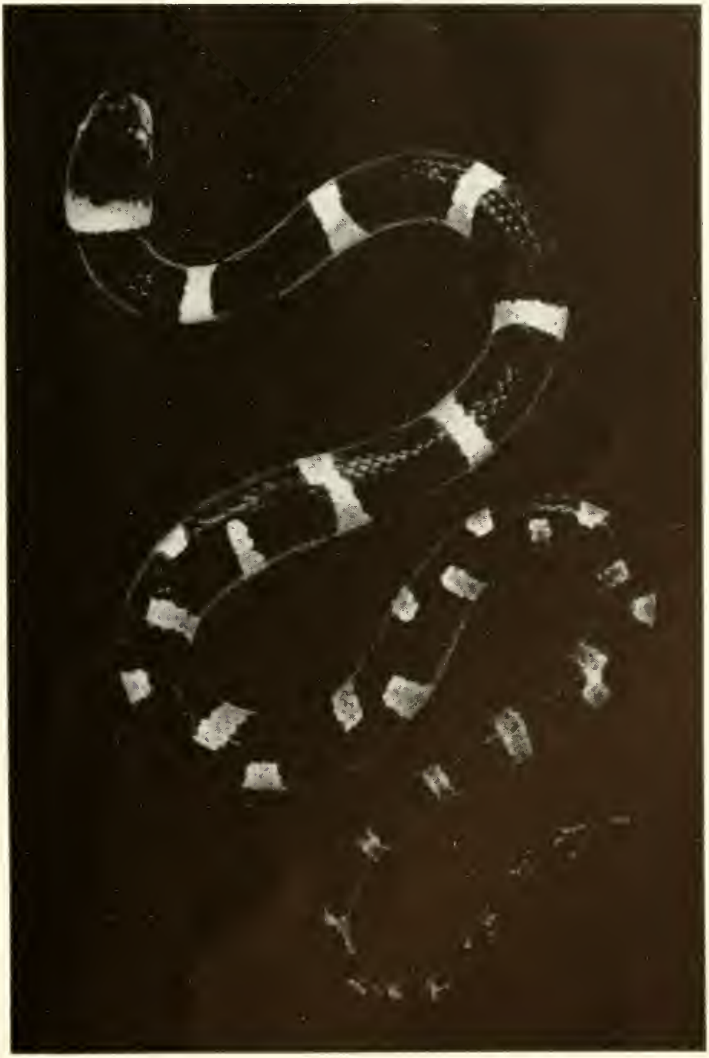

FIG. 17. *Leptodeira nigrofasciata* Günther. K.U.M.N.H. No. 31932; Tenorio, Las Cañas, Guanacaste Prov., Costa Rica. (Young, actual total length, 196 mm.)

and the halves tend to alternate; about nine bands on tail; dark bands on body three to four times wider than gray-white interspaces. Venter bluish white throughout. The total length of the specimen is 197 mm., the tail 43 mm.; maxillary teeth 9, increasing somewhat in size, followed after a diastema by a large grooved fang.

This species is known to range in Nicaragua and Costa Rica, in the Caribbean drainage but still remains very rare in collections.

Leptodeira annulata annulata (Linnaeus)

Fig. 18

Coluber annulata Linnaeus, Amoenitates Academicae. Tomus 1, no. 5, 1745, p. 120 (type locality not given; unknown); Systema Naturae Ed. X, vol. 1, 1858, p. 224.

Leptodeira annulata annulata Taylor, Univ. Kansas Sci. Bull., vol. 34, pt. 1, no. 1, Oct. 1, 1951, pp. 122-125, pl. 12.

The following specimens are referred to this form: K.U.M.N.H. Nos. 34025-34030, Palmar; No. 34024, 15 mi. W San Isidro del General on Dominical Road.

The following characters obtain:

The scale formula is 21-21-21-17-15 in all; supralabials 8-8, the fourth and fifth bordering orbit; the upper preocular touches the frontal; the infralabials ten or eleven with five or six scales bordering the first chinshields.

The general appearance of the specimens from the Caribbean drainage (Morehouse Finca and Los Diamantes) seems rather different. It may be necessary to recognize the western slope specimens under Günther's name *affinis,* but I have not sufficient specimens to determine the matter.

One large specimen figured here, I have referred to this subspecies with reluctance. It is from an unknown locality in Costa Rica. In life the venter was a lively yellow ivory, chin whitish; labials yellowish. Ventrals, 187, subcaudals, 82; 39 spots on body; the scale formula: 19-21-23-23-21-15 which is not typical, at least of the western specimens of this form. A complete understanding of this genus in Costa Rica will require much more collecting. I have not been able to find in Costa Rica any specimen referable to *Leptodeira maculata* but my failure to find it is no criterion to use in proving its absence.

I have been unable to find the rare *Leptodeira rubricata* still known from only the type, although the type locality Boca Malo, Costa Rica located at the mouth of the Río Diquis is near Palmar where collections were made. The very high number of body spots (60) and the unusual red color will easily identify this species.

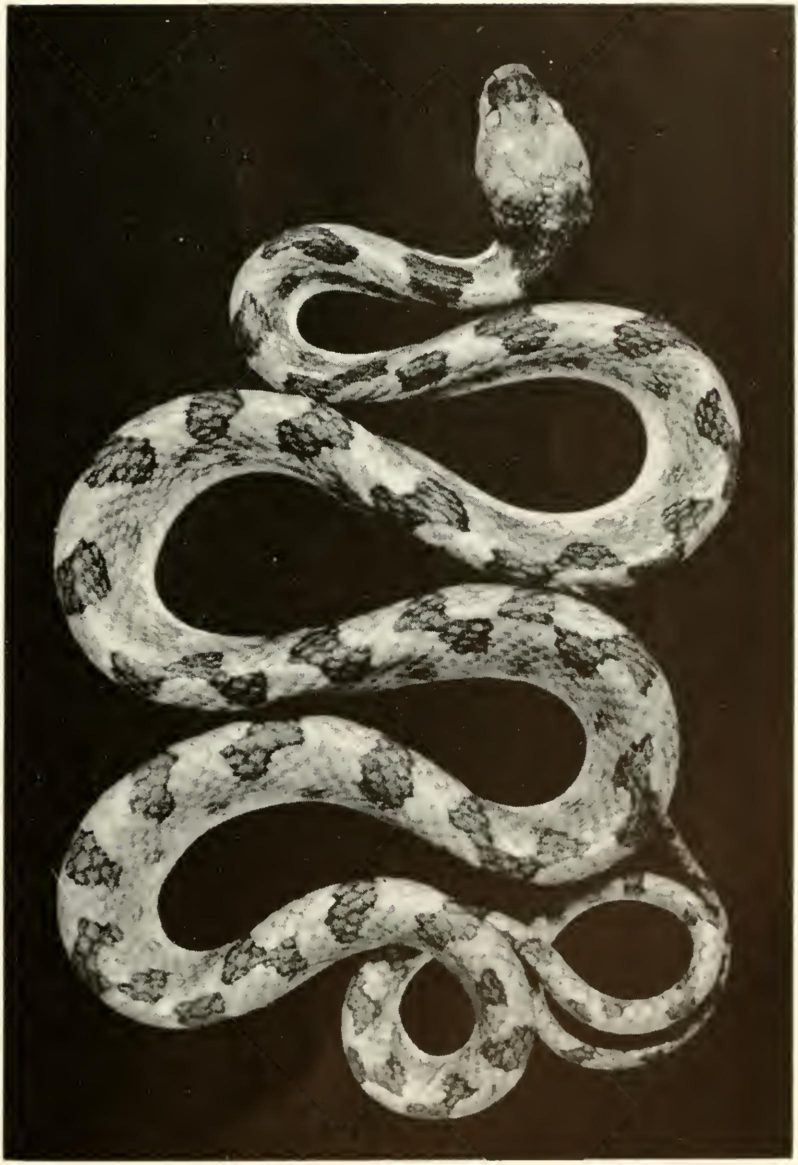

FIG. 18. *Leptodeira annulata annulata* (Linnaeus) K.U.M.N.H. No. 34031; Costa Rica. (About natural size; actual total length 685 mm.)

Table of data on *Leptodeira annulata annulata*

Number	*Sex*	*Ventrals*	*Subcaudals*	*Spots*
34025	♂	194	. .	50
34026	♂	201	. .	45
34027	♂	193	95	48
34028	♀	. . .		44
34029	yg	194	98	45
34030	yg	185	87	45
34024	?	196	97	49

Leptodeira ocellata Günther

Leptodira ocellata Günther, Biologia Centrali Americana: Reptilia and Batrachia, May, 1895, pp. 172-173, pl. 55, fig. B (type locality, Chontales Mines, Nicaragua; Costa Rica); Taylor, Univ. Kansas Sci. Bull., vol. 34, pt. 1, no. 1, Oct. 1, 1951, pp. 125.

Three specimens of this species are in the collection from Palmar—Nos. 34012-34014. The first and last are young, No. 34013 being of medium size. The longitudinal nuchal line is broken in all three specimens. The number of spots varies from 39-44 (about 38 in the types); the ventrals 171-172 (158-170 in the types); the subcaudals 83-88 (74-83 in the types). The scale formula is (26-19)-21-21 (23)-17. (The types with 23 rows). The dorsal spots on these all have lighter edges. A large, badly damaged, road specimen taken at Hotel Marabilla at the mouth of Río Barranca has the markings on the body almost exactly as described by Günther.

Scale data on *Leptodeira ocellata* Günther

Number	34012	34013	34014
Sex	♀	♂	♂
Ventrals	172	171	171
Subcaudals	83	88	86
Dorsal spots	39	44	44
Supralabials	8–8	8–8	8–8
Infralabials	10–10	10–10	10–10
Temporals	1+2+3	1+2+3	1+2+3
Labials border orbit	4th,5th	4th,5th	4th,5th
Labials touch chinshields	5	5	5
Preoculars	2	2	2
Postoculars	2	2	2
Scale formula	19,21,21,17	21,21,23,17	19,21,23,17

Leptodeira rhombifera Günther

Fig. 19

Leptodira rhombifera Günther, Ann. Mag. Nat. Hist., ser. 4, vol. 9, 1872, p. 23 (type locality, Río Chisoy near Cubulco, Guatemala).

Leptodeira rhombifera Mertens, Abh. Senckenb. Naturf. Ges., 487, 1952, pp. 67-68 (El Salvador specimens); Taylor, Univ. Kansas Sci. Bull., vol. 34, pt. 1, no. 1, Oct. 1, 1951, p. 126 (data after Günther).

Collecting at Tenorio, in Guanacaste, enabled me to acquire several specimens of a *Leptodeira* that I am associating with this species. These are characterized as follows:

Reduced number of spots (31-36), a longitudinal black nuchal stripe bordered by a lighter color, the median scale count on middle of body, 23 or 25, subcaudal area pigmented more or less, frontal as long as its distance from snout; two postoculars; two preoculars, the upper barely touching or separated from the frontal, the tem-

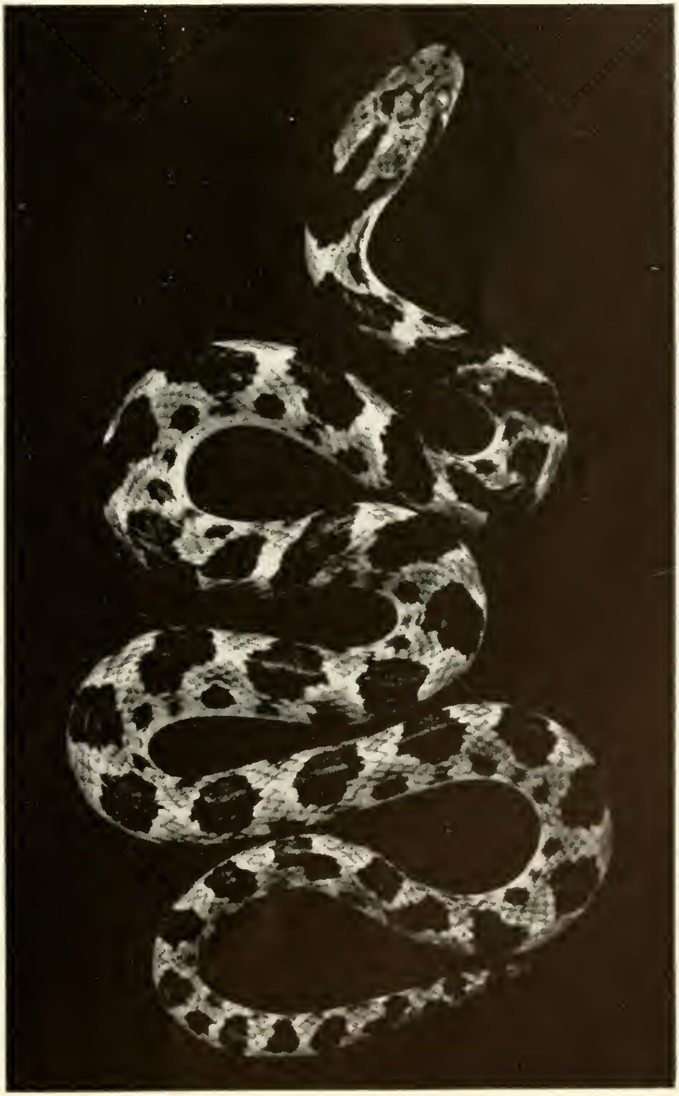

FIG. 19. *Leptodeira rhombifera* Günther. K.U.M.N.H. No. 34018; Tenorio, Las Cañas, Guanacaste, Costa Rica. (About natural size.)

porals, 1+2+3. Two specimens from near the mouth of the Río Barranca at Hotel Maribella, are included in the table.

The type has only a single preocular and 26 dorsal spots. The following table gives some variational data.

One specimen No. 34023 has an azygous scale surrounded by prefrontals and internasals, and one specimen, No. 34019, has three preoculars. It will be noted in the following table that the ventral subcaudal counts for the males are 165-168, 80-89; for females 170-175, 67-71.

Counts for a series from El Salvador given by Mertens (*loc. cit.*) are males 166-168, 77-85; females 169-175, 68-72. These obviously show no significant variation.

In all the specimens the supralabials are 8-8, the fourth and fifth entering the orbit, the postoculars 2-2. With one exception (11-10) the infralabials are 10-10 with the first five touching the first chinshields, which are of nearly the same length as the second pair; the temporal formula is 1+2+3 (in one specimen 1+2+4 on one side). The anal is divided in all. The preocular touches the frontal in four, and is separated in four.

Table of data on *Leptodeira rhombifera* Günther

Number	*Sex*	*Ventrals*	*Subcaudals*	*Body spots*	*Scale formula*
34016	♂	168	82	35	(29-21)-23-23-16
34017	♂	165	80	36	(27-21)-23-25-17
34018	♂	168	30+	31	(27-21)-23-23-17
34019	♂	168	25+	34	(28-21)-23-23-16
34022	♂	167	89	32	(27-21)-23-25-17
34020	♀	170	67	33	(28-21)-23-25-17
34021	♀	175	70	34	(29-21)-23-25-17
34023	♀	170	71	36	(27-21)-23-23-17

Oxybelis brevirostris (Cope)

Dryophis brevirostris Cope, Proc. Acad. Nat. Sci. Philadelphia, 1860, p. 555 (type locality, Veragua, Panamá).

Oxybelis brevirostris Taylor, Univ. Kansas Sci. Bull., vol. 34, pt. 1, no. 1, Oct. 1, 1951, pp. 128, pl. 13.

Two specimens of this species were acquired: K.U.M.N.H. Nos. 30994 and 31898, Turrialba, Costa Rica. The specimens agree well (as far as can be determined) with the specimen from Los Diamantes described by Taylor (*loc. cit.*), save that in both, the temporals differ, the upper secondary temporal being separated from its fellow by three scales, and No. 31898 ♂ has the five median scale rows keeled on the posterior fourth of the body. No. 30994, young (badly mutilated) shows no keels. The former has 176 ventrals and 164 subcaudals (177-162 in the Los Diamantes specimen).

The first subcaudal in No. 31898 ♂ is undivided, the second in No. 30994 ♀.

Oxybelis aeneus (Wagler)

Dryinus aeneus Wagler, in Spix, Serpentum Brasiliensium 1824, p. 12, pl. 3 (type locality, near Ega, Brazil).
Oxybelis aeneus Taylor, Univ. Kansas Sci. Bull., vol. 34, pt. 1, no. 1, Oct. 1, 1951, p. 128 & 130.

One specimen of this snake was acquired at Turrialba (K.U. M.N.H. No. 31894 ♂). I am not at all certain that the name here used is applicable to this species. The scale characters, of this specimen, follow, and should be typical for the Costa Rican population.

Rostral narrow, somewhat procumbent, visible above narrowly; prefrontals long, narrow, about three fourths of the length of prefrontals; latter about seven eighths of the length of frontal, narrow elongate, more than two and a half times longer than wide; parietals more or less notched behind; nasal elongate more than three times as long as high; the nostril diagonally placed; loreal absent; the prefrontals broadly touching two supralabials; a large somewhat quadrangular preocular not reaching upper level of head, widely separated from frontal; supralabials, 8-8, the fourth, fifth, and sixth entering the orbit; two small postoculars; temporals, 1+2; the parietals and temporals bordered behind by four large elongate scales separated by a tiny mesial scale; infralabials, 8-9, four or five touching the first pair of chinshields; first infralabials large with a common suture a third shorter than that of the first chinshields; second chinshields longer than first pair.

Scale formula 17-17-17-15-13; the scales unkeeled; ventrals 184; anal divided; 180 subcaudals all divided except terminal.

The specimen is discolored so the color description is omitted.

Imantodes inornatus Boulenger

Himantodes inornatus Boulenger, Catalogue of the Snakes in the British Museum, vol. 3, 1896, p. 88, pl. 5, fig. 1 (type locality, Hda. Rosa de Jéricho, 3250 ft., elev., Nicaragua).
Imantodes inornatus Taylor, Univ. Kansas Sci. Bull., vol. 34, pt. 1, no. 1, Oct. 1, 1951, pp. 130-132, pl. 14.

A specimen, K.U.M.N.H. No. 31919, female, acquired at San Isidro del General, agrees with the figure given by me, (Taylor, *loc. cit.*) in color and markings. The body is strongly compressed. The following characters vary; the supraoculars reach halfway down behind eye, (perhaps fused with a postocular); there are three preoculars, the upper large, touching frontal; the scale formula is 17-17-17-15, the scales smooth. The ventrals are 213; subcaudals 119; anal divided. Behind each eye is a large swollen gland completely symmetrical of orange color. It occupies an area below the last supralabials and extends somewhat under the eye. This swollen gland has been observed in certain other species of *Imantodes.*

The color characters given by Taylor, including the narrow black nuchal line, the dark dashes and dots on head, the fine median ventral line, and the dorsal marking are reproduced faithfully in this specimen.

Imantodes cenchoa semifasciatus Cope

Fig. 20

Himantodes semifasciatus Cope, Amer. Nat., 1894, p. 613 (type locality, Costa Rica and Nicaragua).

Imantodes cenchoa semifasciatus Taylor, Univ. Kansas Sci. Bull., vol. 34, pt. 1, no. 1, Oct. 1, 1951, pp. 132-134, pl. 15, (three specimens said to be from Turrialba are actually from Cinchona [Isla Bonita]).*

Specimens from the following localities are at hand: K.U.M.N.H. No. 34032, Turrialba; No. 34033, La Lola, Limón Province; Nos. 34034, 31946, Tenorio (ranch), Las Cañas, Guanacaste; No. 34035, Golfito, Puntarenas Province, Costa Rica.

Scale data on *Imantodes cenchoa semifasciatus*

Number	*Sex*	*Pre-oculars*	*Post-oculars*	*Ventrals*	*Sub-caudals*	*Anal*	*Supra-labials*	*Infra-labials*
34032	♂	1-1	2-2	247	163	2	8-8	10-10
34033	♂	1-1	2-3	251	178	2	8-8	11-10
34034	♀	1-1	2-3	236	149	2	8-8	10-10
31946	♂	1-1	2-2	252	166	2	8-8	10-10
34034	♀	1-1	2-3	246	157+	2	8-8	10-10

There is seemingly an inconsistency in the preceding data since the females of most species of snakes have a larger number of ventrals and a smaller number of subcaudals than the males. In this form the females I have examined have fewer ventrals than the males and at the same time a smaller number of subcaudals. Thus in the males, ventrals vary from 247-252; subcaudals 163-178; in females 233-246; 149-157; total ventral counts: males, 410-429; females, 385-403. A male from Los Diamantes has 419- a female 390 ventral-subcaudal count; a pair from Tenorio have 418 and 385, a difference of 29 and 33 scales.

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* They were, however, collected in 1947 at the American Cinchona Plantation, Isla Bonita, by R. C. Taylor. These specimens were kept alive at Turrialba, and later preserved there, which resulted in their having been mislabeled.

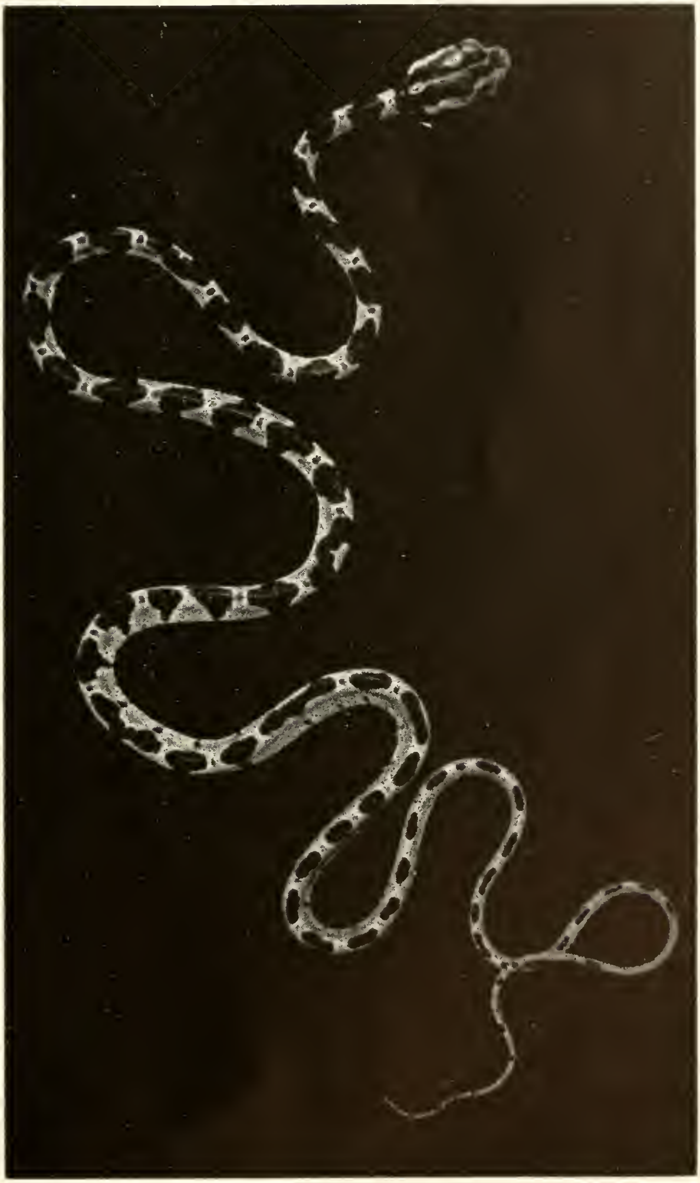

FIG. 20. *Imantodes cenchoa semifasciatus* Cope. K.U.M.N.H. No. 31946, Tenorio, Las Cañas, Guanacaste Prov., Costa Rica. (Young. About natural size.)

The specimens from eastern lowland localities have a dim median brown line discernible on the venter. One of the specimens from Tenorio, a juvenile, has blackish blotches on the back with small black spots on the middorsal line between the blotches.

The specimen from Golfito has the ground color dark brown so that the blotches are not so easily discerned. These blotches reach and extend onto the ventrals. The typical head markings, consisting of a spot on snout and two broad stripes extending to and joining on the neck are completely absent, the top and sides of head being more or less uniform brown. There are 38 body blotches on the body, while those on the tail cannot be counted with certainty. In the middle of the body the blotches may cover 5 to 5½ scale-lengths, and are separated by lighter blotches (without black spots) covering, on midline, usually less than three scale-lengths. Below, the chin and neck are white, while the greater part of the venter is strongly and coarsely peppered with brown, more dense under the tail. The gland below the sixth and seventh supralabials is yellowish as is more or less usual in *Imantodes*.

Imantodes gemmistratus Cope

Fig. 21

Himantodes gemmistratus Cope, Proc. Acad. Nat. Sci. Philadelphia, vol. 13, 1861, p. 296 (type locality, "near Izalco, San Salvador").

Imantodes gemmistratus Mertens, Abh. Senck. Natur. Ges., 487, Jan. 12, 1952, p. 65; Taylor, Univ. Kansas Sci. Bull., vol. 34, pt. 1, no. 1, Oct. 1, 1951, p. 135.

A single specimen, K.U.M.N.H. No. 31945, Los Diamantes, near Gúapiles, was collected by me from a bromelia. The following characters obtain:

Rostral visible at a point from above, its width distinctly greater than its height; internasals small, narrowed to a point laterally, their greatest mesial length about two thirds length of prefrontals; latter broader than long, their sutures with the frontal forming a straight line; frontal one-sixth longer than broad, its length distinctly greater than its distance from the tip of snout; supraoculars large, much wider posteriorly; parietals longer than broad, their length equal to their distance from the tip of snout, their outer edges somewhat irregular; nasal completely divided, with nostril lunate; loreal distinctly higher than long; one large preocular not reaching the frontal; two small postoculars (upper on left side fused to supraocular); temporals, 2+3+3; supralabials, 8-8, the fourth and fifth enter orbit, the temporal region swollen; infralabials, 9-10, six touch first chin-

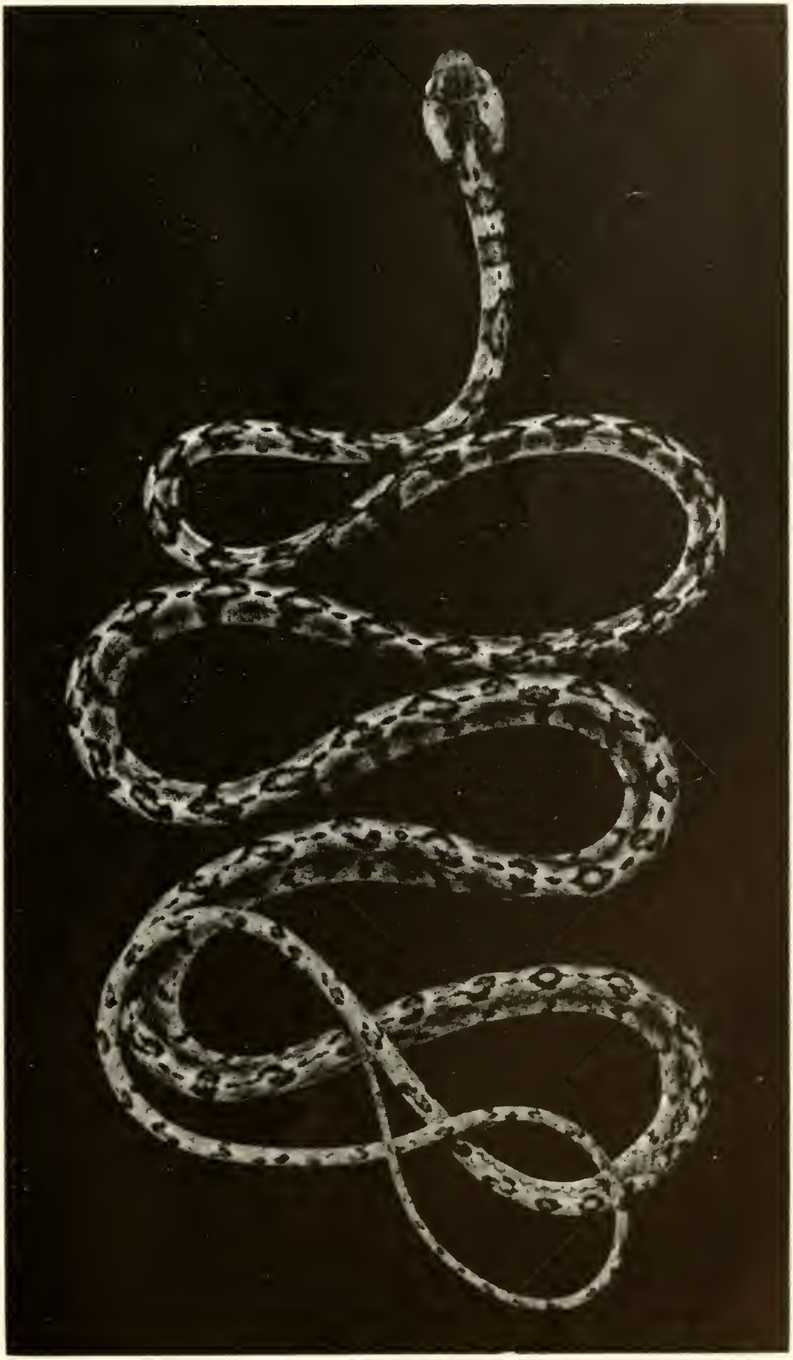

FIG. 21. *Imantodes gemmistratus* Cope. K.U.M.N.H. No. 31945; Los Diamantes, Limón Prov., Costa Rica. (About natural size.)

shields, the sixth broadly in contact with second chinshields; first labials very narrowly in contact, almost separated by mental; first chinshields wider and longer than second pair, which is separated by small scales; scale row formula: 17-17-17-15, the median row anteriorly somewhat enlarged, but throughout most of body they are one and one-half to two times the width of the adjoining scales. Scales on sides minutely corrugated, the outer row nearly smooth; ventrals, 237, anal divided, subcaudals, 144.

Color above fawn, with 59 small brown blotches reaching onto outer edges of ventrals, widest dorsally where they cover about two or two and one-half scale-lengths, and enclose a lighter spot posteriorly. On the latter half of body spots broken laterally leaving a median and two lateral dark spots; about 28 spots on tail, the spots becoming obsolete toward tip. On head a pair of broad darker-bordered stripes beginning on anterior half of parietals, terminating at eighth transverse row; these preceded by eight spots on parietals, frontal, and supraoculars; snout and sides of head with small flecks, larger flecks on rostral and first three labials. Chin white with dark dots on mental and first three labials; venter and subcaudal area peppered with tiny flecks of brown; temporal region cream.

Measurements in mm.: Total length, 595; tail, 187; width of head, 9; length of head, 11.

Remarks: This specimen does not fit into the general pattern of *gemmistratus* or of *stratissima* Cope. The latter nominal species has a ventral count of 232, subcaudals 130, total 362 (this specimen has a total of 381); the number of dorsal spots on body and tail are 108 (in this about 87). Cope's description of the markings, "bands of deep brown which narrow a little on the sides and have broadly rounded extremities at the second row of scales. The centres of the spaces between them on the side are occupied by a light brown spot. Each gastrostege has a dark brown spot on its extremity. . . ." "Three brown chevrons in the parietal region directed backwards"—suggest a very different snake from this one before me.

Cope's description of *gemmistratus* likewise shows characters differing from this. The characters in which it differs are as follows:

Scales of the median row *diamond-shaped,* longer than broad; one temporal touches postoculars; sixth inferior labial largest; 42 spots on body, connected with a dorsal vitta; belly punctulated laterally but without a median vitta. Head pale brown, varied with a few irregular darker marks; pores in scales single.

In my specimen the median scales are not in any sense diamond-shaped; the number of the spots is significantly different (42 compared to 59); head not pale brown, and I cannot discern single apical pores. Cope does not report the ventrals and subcaudals of his type.

Wettstein (Sitz. Akad. Wiss. Wien, Math.-Natur. Kl. Abt. 1, Bd. 143, Heft 1 and 2, 1934, p. 36.) reports two specimens of *Imantodes* from Port Limón of which he states: "eines zu *cenchoa,* eines zu *elegans* gehört, beweist wohl deutlich dass *elegans* nur eine ganz unbedeutende Varietät von *cenchoa,* aber keine eigene Art ist."

My specimen probably approaches *elegans* but the latter I believe definitely belongs to a species different from *cenchoa.* Whether it should be regarded as a synonym of *gemmistratus* is a matter that I regard as unsettled. An accumulation of Costa Rican materials will doubtless warrant separation from *gemmistratus* of the Costa Rican population, of which my specimen is an example.

Clelia clelia clelia (Daudin)

Coluber clelia Daudin, Histoire Naturelle, Générale et Particulière des Reptiles, vol. 6, 1803, pp. 330-331, pl. 78 (type locality, Surinam).

Clelia clelia clelia Taylor, Univ. Kansas Sci. Bull., vol. 34, pt. 1, no. 1, Oct. 1, 1951, pp. 135-137, pl. 16 (juvenile).

An adult specimen, K.U.M.N.H. No. 31975, was captured in 1952 as it was passing under the guest house at Moravia de Chirripo.

The scale formula is, 17,17,17,15; all the scales smooth, and as far as I can discern, lacking apical pits. Ventrals, 221; subcaudals incomplete; supralabials, 7-7, the third and fourth entering orbit; infralabials, 8-8, the first five touching the first chinshields.

Three young specimens, Nos. 31895-31897, are from Cinchona. They are typical and resemble rather faithfully the specimen figured by Taylor (*loc. cit.*) save that being younger the pigment spots are somewhat smaller.

Clelia petolaria (Linnaeus)

Coluber petolarius Linnaeus, Syst. Nat., 10th ed., vol. 1, 1758, p. 225; Museum Adolphus Friderici Regis, 1754, p. 35, pl. 9, fig. 2.

Clelia petolarius Taylor, Univ. Kansas Sci. Bull., vol. 34, pt. 1, no. 1, Oct. 1, 1951, pp. 138-139, pl. 17.

Four specimens are in the collection, as follows: Three specimens, a young adult, K.U.M.N.H. No. 31974, John Baker, coll., a juvenile specimen, No. 34833, collected by Mrs. Albert Weyer, and a large adult, No. 34899, taken by me, are from Golfito, Puntarenas Province; No. 34894 from La Lola, Limón Province.

The juvenile (red and black banded) male specimen, No. 34833, resembles in pattern the figure given by Taylor (*loc. cit.*); the body bands are somewhat more numerous (34) while 20 can be discerned on the tail. Ventrals, 202; subcaudals, 102; anal single; scale formula, 19,19,19,17, with paired apical pits; supralabials, 8-8, infralabials, 10-10.

No. 31974 ♂ is a young adult that has lost all trace of the red banding. Ventrals, 226; subcaudals, 92; supralabials, 7-8; infralabials, 8-8; scale formula, 19,19,19,17. This specimen was captured at night in a low pasture.

No. 34894 is a large male specimen, taken at night on a golf course at the edge of a forest. Ventrals, 227; subcaudals, 94; supralabials, 7-7, third and fourth enter orbit; infralabials, 8-8, five touching first chinshields. Scale formula: 19, 19, 19, 17.

No. 34899 from La Lola is a gigantic specimen measuring 2,200 mm., the tail, 332+ mm. (mutilated). The ventrals are 244, subcaudals, 61+. Scale formula: 19,19,19,17. Supralabials, 7-7, the third and fourth entering orbit; infralabials, 8-8, five touching first chinshields. This specimen was captured in a clearing.

Erythrolamprus bizonus Jan

Erythrolamprus aesculapii bizona Jan, Arch. Zool. Anat. Fis.,* vol. 2, fasc. 2, 1863, pp. 314-315.

Erythrolamprus bizonus Taylor, Univ. Kansas Sci. Bull., vol. 34, pt. 1, no. 1, Oct. 1, 1951, p. 140.

The series of specimens belonging to this species are K.U.M.N.H. Nos. 30973-75, 31892, 31989-91, 34840, 34884-87 from I.A.I.A. Turrialba, except No. 31890, Las Flores, Tenorio, Las Cañas, Guanacaste; No. 31891, Tunnel Camp near Peralta, and No. 31889 from an unknown locality. A crushed specimen was taken at an elevation of approximately 5,000 ft. on the Pan-American Highway about 12 kilometers south of Cartago. This was not preserved.

Table of scale counts of *Erythrolamprus bizonus* Jan

Number	*Sex*	*Ventrals*	*Subcaudals*
30973	♂	198	53
39074	♀	195	48
39075	♂	195	56
31892	♀	194	52
31989	♂	199	58
34840	♀	193½	49
34884	♀	195	49
34885	♂	197½	55
34886	♂	196	57
34887	♀	196	47
31889	♂	199	58
31891	♂	194	57
31890	♂	195	60

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* This publication referred to by Boulenger erroneously as Arch. Zool., Anat. Phys. and by Taylor as Arch. Anat. Zool. Phys. has caused considerable confusion on the part of a subsequent worker, and has unwittingly caused elaborate and laborious search for a nonexistent publication. See, Bull. Comp. Zool., vol. 87, Mar. 1941, p. 513.

Coniophanes fissidens punctigularis Cope

Fig. 22

Coniophanes punctigularis Cope, Proc. Acad. Nat. Sci. Philadelphia, vol. 12, 1860, p. 248 (type locality, Honduras).

Coniophanes fissidens punctigularis Taylor, Univ. Kansas Sci. Bull., vol. 34, pt. 1, no. 1, Oct. 1951, pp. 142-143, pl. IV, fig. 1.

Five specimens, K.U.M.N.H. Nos. 30976-30979, and No. 34834 are from the farm of the Inter-American Institute of Agriculture, at

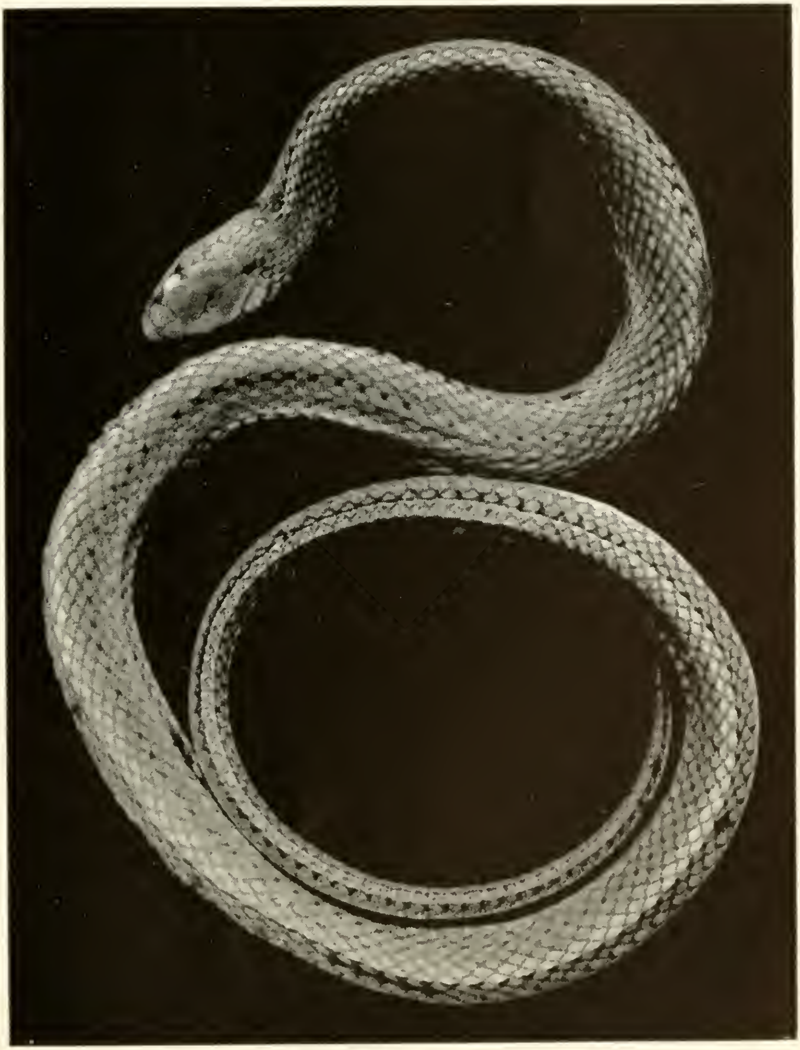

FIG. 22. *Coniophanes fissidens punctigularis* Cope. K.U.M.N.H. No. 34834; Turrialba, Costa Rica. (Enlarged, actual total length 335 mm.)

Turrialba and all conform in general to the characters of this species. The temporals are 1+2 (save one has the first temporal broken on one side) and there are two postoculars, one preocular, supralabials, 8-8, infralabials, 10-10. The scale formula is 21-21-17, the scales lacking pits and keels. The sex and ventral subcaudal counts where known are respectively as follows: ♂ 115, ?; ♂ 115, ?; ♂ 114, 73; ♀ 119, 65; ♂ 116, ?; anal divided in all.

Stenorrhina degenhardti degenhardti (Berthold)

Fig. 23

Calamaria degenhardtii Berthold, Abhand. Ges. Wiss. Göttingen, vol. 3, 1846, p. 8, pl. 1, fig. 2, 4 (type locality, Mexico and Central America. The northern form has been separated as *degenhardti mexicana*, the type locality restricted to Córdoba, Veracruz. The typical form is from Central America).
Stenorrhina degenhardtii degenhardtii Taylor, Univ. Kansas Sci. Bull., vol. 34, pt. 1, no. 1, Oct. 1, 1951, pp. 146-147 (Costa Rican specimens).

The specimen, K.U.M.N.H. No. 31931 that I am placing under this name, comes from the Pacific slope of Costa Rica at San Isidro del General. Previously known specimens have been from the east coast.

The dentition is somewhat reduced there being 10 maxillary teeth followed after an interval by an enlarged grooved fang. The prefrontal touches labials on one side only, a small loreal being present on the other side.

The specimen is light tan with 23, somewhat quadrangular, black or black-brown blotches on body (that on neck somewhat more elongated). On body, except on anterior part, smaller median spots intercalated between the larger; laterally two or three alternating rows of dashlike spots, more irregular on outer scale rows. The tail has five larger spots with numerous other small spots. Venter whitish, each scale with one to four black spots, many nearly triangular, tending to alternate but occasionally contiguous, darker under tail. The top of the head is light brown with five or seven small dark spots, more or less symmetrically arranged.

The following scale characters obtain: Scale formula (21-17)-17-17; supralabials, 7-7, the second and third entering eye; loreals, 1-0; infralabials, 7-7, three touching first chinshields; preocular, 1-1; postocular, 2-2; second chinshields small, barely in contact; ventrals, 166; anal divided; subcaudals, 35. Scales smooth without pits.

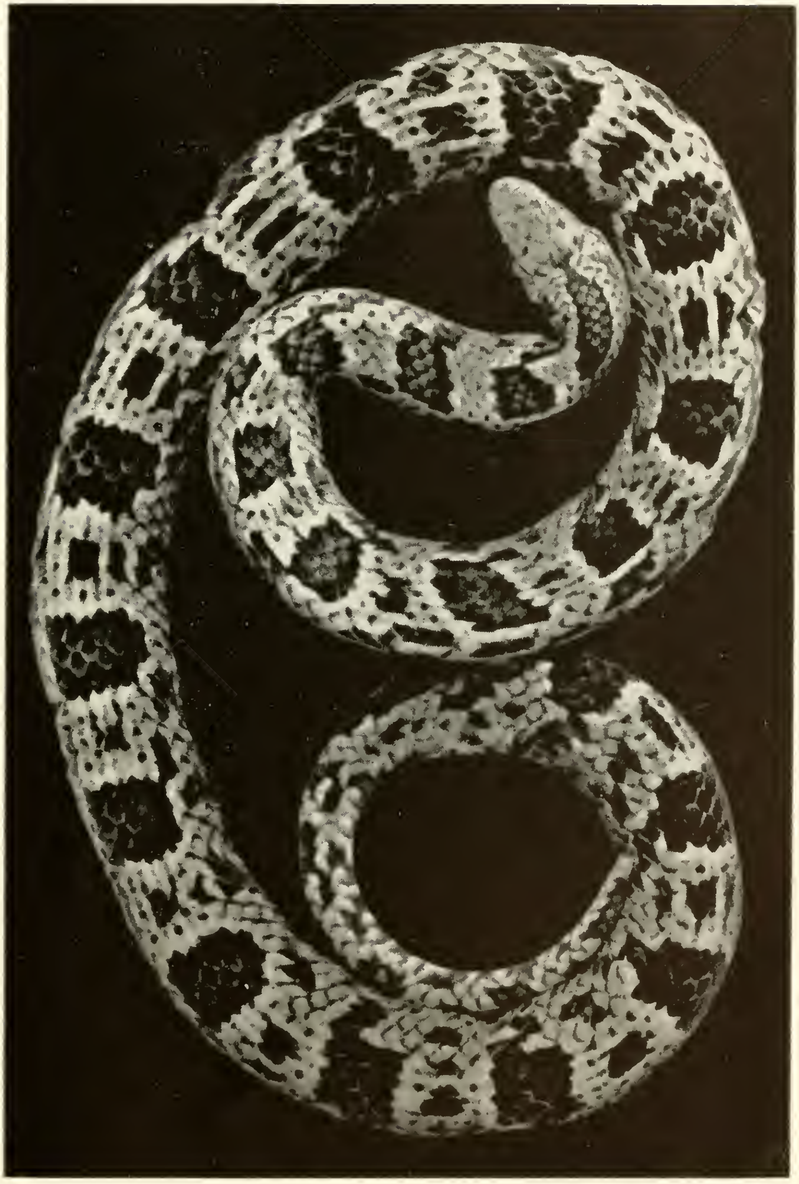

FIG. 23. *Stenorrhina degenhardti degenhardti* (Berthold). K.U.M.N.H. No. 31931; San Isidro del General, San José Prov., Costa Rica. (About natural size.)

Stenorrhina degenhardti subsp.?

Fig. 24

This specimen from Turrialba, Costa Rica, K.U.M.N.H. No. 31977, does not seem to agree with forms previously recognized from this region. I am uncertain as to its subspecific relationship.

The most striking characters separating it from the preceding snake are: (1) the internasals equally as long as prefrontals, fused to the anterior nasal; (2) the posterior nasal broadly in contact with the preocular, the loreal absent; (3) frontal as long as parietals; (4) dorsal and lateral color nearly uniform gray above, the

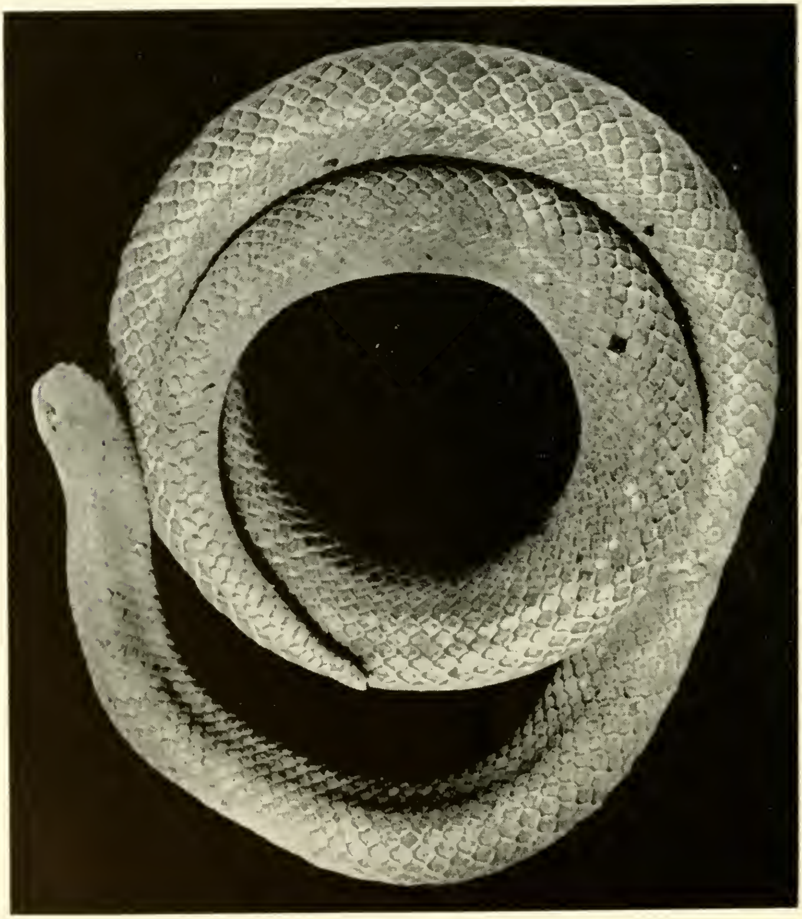

FIG. 24. *Stenorrhina degenhardti* subsp.? K.U.M.N.H. No. 31977; Turrialba, Costa Rica. (About natural size.)

individual scales showing some uniform variation in darker and lighter marks, with an occasional black scale present. (5) Chin white to first ventral. Anterior ventrals light with edges marked with transverse black lines, the line gradually widening on ventrals posteriorly; the pigment darkest and widest near the median line of the venter.

Ventrals 157; anal divided; 32 subcaudals; scales 17-17-17. (24 about back part of head.)

The specimen is a female containing numerous eggs. It is a gift from my friend Julio Valerio, who collected it at Turrialba.

Tantilla annulata Boettger

Tantilla annulata Boettger, Zool. Anz., 1892, p. 419 (type locality, Nicaragua); Taylor, Univ. Kansas. Sci. Bull., vol. 34, pt. 1, no. 1, Oct. 1, 1951, pp. 149-152, pl. 18, (Costa Rican records).

Specimens of this snake in the collection are K.U.M.N.H. Nos. 30938, July 3, 1931; No. 30939, late August, both from Turrialba, Costa Rica, and No. 34832 from Golfito, collected by Mrs. Weyer.

Scale data on *Tantilla annulata*

Number	30938	30939	34832
Ventrals	147	147	148
Subcaudals	59	58	46–

Tantilla armillata Cope

Fig. 25

Tantilla armillatum Cope, Journ. Acad. Nat. Sci. Philadelphia, ser. 2, vol. 8, 1876 (1875), p. 143 (type locality, "middle Costa Rica"); Taylor, Univ. Kansas Sci. Bull., vol. 34, pt. 1, no. 1, Oct. 1, 1951, pp. 152-153; Dunn and Bailey, Bull. Mus. Comp. Zool., Harvard College, vol. 86, no. 1, Oct., 1939, p. 19 (Caña, Panamá).

Homalocranium armillatum Günther, Biologia Centrali-Americana; Reptiles and Batrachians, Jan. 1895, p. 149, pl. 52, fig. C.

One specimen, K.U.M.N.H. No. 31960, was collected on the Dominical Road about 10 mi. WSW of San Isidro del General, July 10, 1952.

The pattern of squamation is in accord with the type in having the mental separated from the chinshields, the prefrontals touching the labials and separating the posterior nasal and preocular, and seven upper labials. Compared with Günther's figure (*loc. cit.*) the specimen at hand has a median dark line, the sixth and seventh scale rows being a little lighter than the fifth row which has a blackish edge both above and below anteriorly, but seemingly the three rows are identical posteriorly. The white line on the third and fourth rows presents a wavy appearance, as does the black

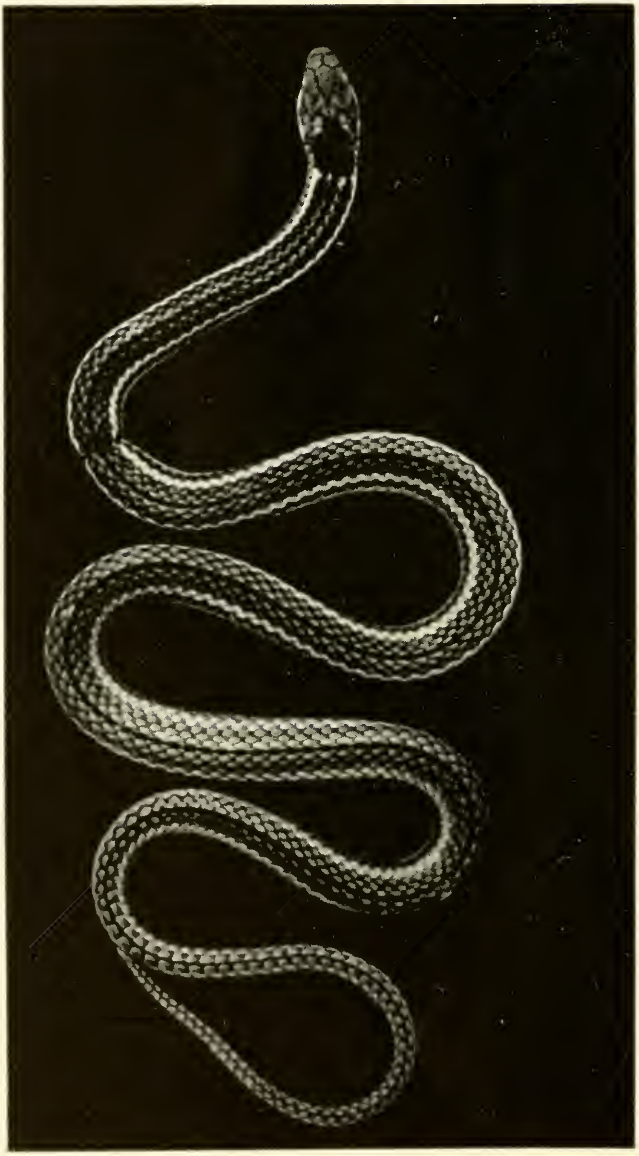

FIG. 25. *Tantilla armillata* Cope. K.U.M.N.H. No. 31960; 10 mi. WSW San Isidro del General, San José Prov., Costa Rica. (About natural size; actual total length, 292 mm.)

borders of the white line. The first scale row is light with a somewhat diagonal black line anteriorly, a dimmer longitudinal line posteriorly, the pigment encroaching on the ventrals. The deep black of rows two and three becomes much lighter posteriorly. The top of the head is brownish with spots on the back of the parietals; laterally the labials in front of the eye are ivory save for small dark marks on the upper edges of the second, third, and fourth labials and small sutural marks between the last three; an irregular dark line runs back from eye to the dark nuchal area crossing first temporal and upper part of seventh labial. The venter is white becoming bluish white under the subcaudal region where there is some pigment along the middle line. The chin is white, the infralabials bearing darker spots, or lines, along the sutures, the mental being largely dark.

The temporals are 1+1. The second temporal alone touches the first but posterior to the seventh labial is a second temporal. In this it agrees with the type specimen.

The general pattern of the collar does not fit the type description or the one figured by Günther (which may or may not be from Costa Rica). The two specimens listed by me (*loc. cit.*) likewise show some variation. It is doubtful that the variations are worthy of nomenclatorial recognition.

The ventral and subcaudal counts are low, 148, 67 with a total of 215 ♂. (The type has 166, 50; total 216 ♀ ?; Harvard No. 15285, 174 ventrals, ?; U.S.N.M. No. 9787, 169, 47, total 216.)

Tantilla shistosa (Bocourt)

Homalocranium shistosum Bocourt, Mission Scientifique au Mexique et dans l' Amérique Central. Études sur les reptiles, livr. 9, 1883, p. 584, pl. 36, figs. 10, 10a-10c (type locality restricted to Alta Verapaz [by Stuart, 1948]; Dunn and Bailey, Bull. Mus. Comp. Zool. Harvard College, vol. 86, no. 1, Oct. 1939, p. 19 (Canal Zone); Taylor, Univ. Kansas Sci. Bull., vol. 34, pl. 1, no. 1, Oct. 1, 1951, p. 155.

The specimens in the collection are, K.U.M.N.H. Nos. 34039-34041, Cinchona (Isla Bonita) Costa Rica; 34042, I.A.I.A. Turrialba.

Scale data on *Tantilla shistosa*

No.	34039	34040	34041	34042
Ventrals	149	147	150	141
Subcaudals	33	39	35	34
Totals	182	186	185	175

The three younger specimens No. 34039-34041 are brown above with a yellowish neck band and without spots on sides of head. Belly anteriorly maroon becoming pinkish red to tip. No. 34042 is coral pink below.

Dunn and Bailey report a specimen from the Canal Zone having 132 ventrals and 34 subcaudals, total 166.

Tantilla costaricensis sp. nov.

Fig. 25a

Type: K.U.M.N.H. No. 30995, Cervantes, Cartago Province, Costa Rica, elevation about 4,200 ft., Aug. 30, 1951, Edward H. Taylor, collector.

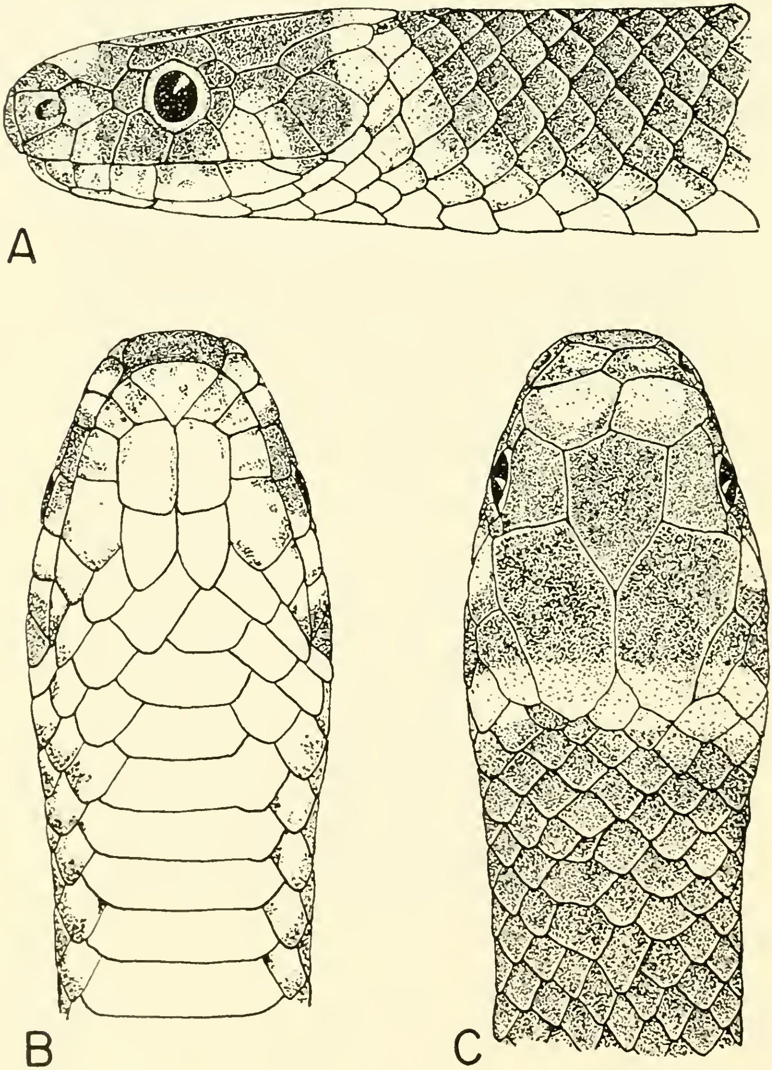

FIG. 25a. *Tantilla costaricensis* sp. nov. Type, K.U.M.N.H. No. 30995, Cervantes, Costa Rica. (× 5.)

Diagnosis: Related to *Tantilla shistosa* but more robust with a longer frontal, (distinctly longer than its distance from tip of snout); head black, with a pair of rather large brownish spots on prefrontals; a white spot involving part of first two labials and posterior nasal; a large salmon spot covering parts of first temporal and the fifth and sixth labials; scales of first and second scale rows with ivory-white centers anteriorly, the white disappearing after a short distance. Chin and throat ivory; venter and under tail deep salmon; four labials touching first chinshields; a nuchal band present. Dorsally brown, the scale centers somewhat lighter.

Description of type: Part of rostral narrowly visible above, not angular, equal to the width of the internasals; latter narrow, twice as wide as their length; length of prefrontals twice (or a little more) length of internasals, much wider than long, angular on the side, narrowly separated from second labial; frontal pointed behind, its length one-fourth greater than its distance from tip of snout; supraoculars short, about a fourth longer than wide; length of parietal equal to its distance from tip of snout; nasal undivided more than twice as long as high, touching preocular narrowly; preocular higher than wide, not reaching top of head; two postoculars; anterior temporal about a fourth longer than high, followed by an elongate secondary temporal more than twice as long as high, and with the lower secondary temporal below its posterior part, separated from the anterior; seven supralabials, the third and fourth entering eye, the third very narrowly in contact with the preocular; six infralabials, the first four touching the first chinshields. Mental large, equal in width to rostral, touching chinshields; first pair of chinshields much longer and somewhat wider than second pair; scales smooth, the formula: 15-15-15; ventrals, 145; anal divided; subcaudals, 18+ (the tip of tail missing).

Color: Above brown, the scales darker edged; head black with two light spots on prefrontals, and a narrow light band across back of parietals and nape of neck; a yellowish spot below and partly behind nostril, and another on the lip behind eye that is rather salmon in color. A row of light spots on scales of the anterior part of the first scale row, a few also on second row. Chin and neck white or ivory white, with slight pigmentation on infralabials and mental; becoming deep salmon on remainder of venter and tail. Ventrals narrowly edged with brown.

Measurements in mm.: Snout to vent, 262; tail, 28+ (mutilated) width of head, 6.8; length of head, 9.2.

Remarks: This species seemingly is related to the *Tantilla shistosa*. The latter species maintains a color pattern which lacks lateral head markings with considerable constancy. It is known to range from Alta Verapaz, Guatemala to Panamá.

Dipsas anthracops (Cope)

Fig. 26

Leptognathus anthracops Cope, Proc. Acad. Nat. Sci. Philadelphia, 1868, pp. 108, 136 (type locality, Central America).

Dipsas anthracops Taylor, Univ. Kansas Sci. Bull., vol. 35, pt. 1, no. 1, Oct. 1, 1951, pp. 58-59.

? *Sibynomorphus ruthveni* Barbour and Dunn, Proc. Biol. Soc. Washington, vol. 34, 1921, p. 158 (type locality, Aguacate Mountains, Costa Rica).

A female specimen of this snake, K.U.M.N.H. No. 31893, was obtained at Tenorio, Guanacaste, Costa Rica, under a loose piece of bark on the trunk of a living tree at about 12 feet above the ground.

The color (in life) of the head is black with the greater part of the chin, lower labials, and posterior upper labials white; the temporal region is yellow and nape of neck pink. Body black above with three transverse rings on the neck yellow, the other rings on body and tail brick red, edged with cream yellow; below, the bands are cream white, the dark bands gray-black.

The reddish bands on the body and tail have numerous elongate black flecks and a small blackish spot on outer scale row sometimes extending onto the ventrals; the black bands are somewhat irregular, only an occasional one actually connected on venter; twenty light bands on body, 12 on tail, the anterior ones separated by black spots as long as ten or eleven scale-lengths, and posteriorly by as few as four scale-lengths.

The scale characters are: rostral wider than high, visible above as a line; internasals wider than long; prefrontals large, wider than long entering eye; frontal longer than its distance from tip of snout; parietal length equals distance of parietal from internasal; nasal divided; loreal about one and one-third times as long as high; no preocular, two postoculars; temporals, 1+2+3; supralabials, 7-7, the three anterior high; fourth and fifth entering orbit; infralabials, 9-8, six or five bordering the first pair of chinshields; latter longer and slenderer than second pair of chinshields; third pair wider than long; the first labials are widened at their common suture (as if a small pair of chinshields had fused with them); eye large, its diameter equal to length of snout. No apical pits visible; scale formula 20 (around back of head), 13, 13, 13, 15 (the latter

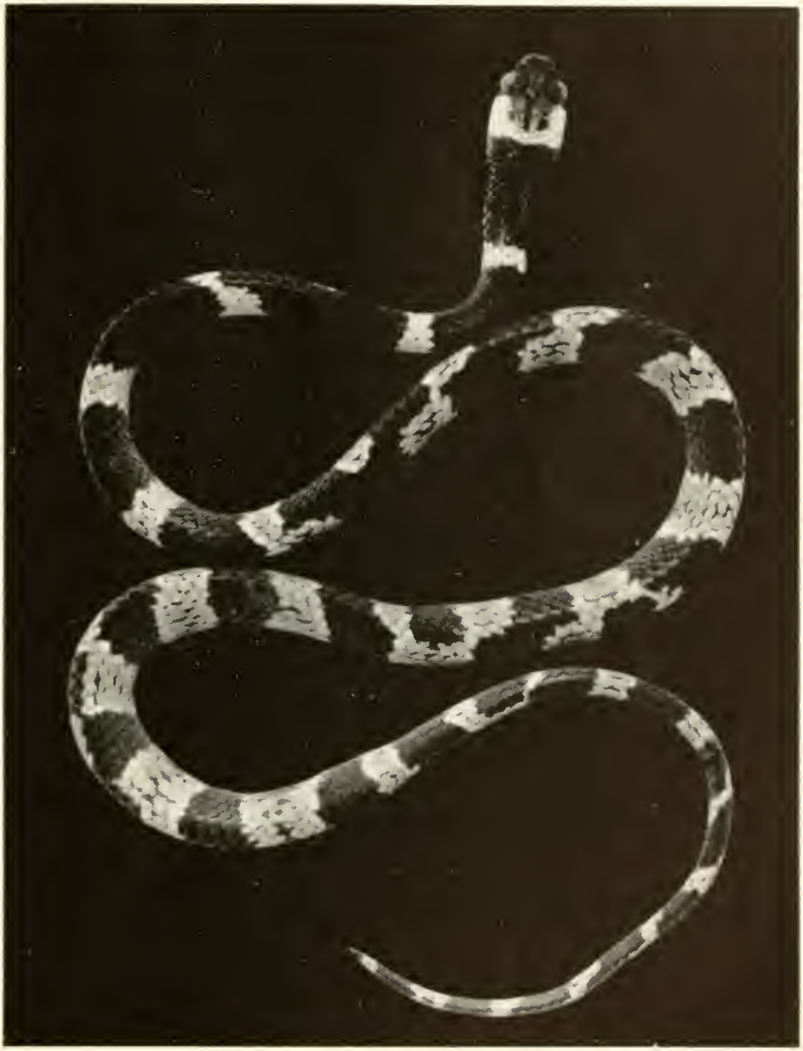

FIG. 26. *Dipsas anthracops* (Cope). K.U.M.N.H. No. 31893; Tenorio, Las Cañas, Guanacaste, Costa Rica. (About natural size; actual total length, 371 mm.)

count just in front of vent). Ventrals, 175; anal single; subcaudals, 76; total length, 371.3 mm., tail, 88.9 mm.

The differences between this form and *ruthveni* is indeed slight. The loreal is relatively longer in proportion to its height and the color may be different. The red color fades quickly and is gone completely after two to three weeks in preservative (formalin and alcohol).

Dipsas annulata (Günther)

Fig. 27

Leptognathus annulatus Günther, Ann. Mag. Nat. Hist., Ser. 4, vol. 9, 1872, p. 30, (type locality, Cartago, Costa Rica).

Dipsas annulata Taylor, Univ. Kansas Sci. Bull., vol. 34, pt. 1, no. 1, Oct. 1, 1951, pp. 61-62, pl. 3, fig. 1. (Costa Rican specimen described).

A specimen of this rare snake was discovered at night in plants (*caña brava*) about 14 feet from the ground on the edge of a stream

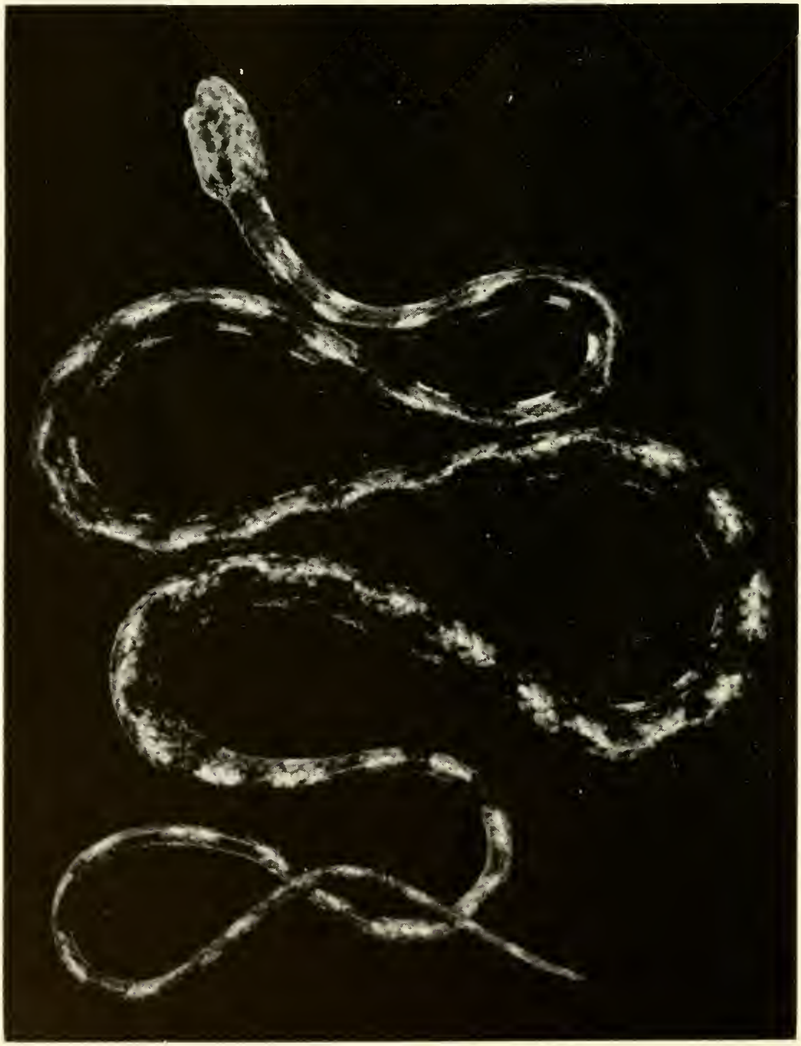

FIG. 27. *Dipsas annulata* (Günther) K.U.M.N.H. No. 31950; Moravia de Chirripo, Limón Prov., Costa Rica. (About natural size.)

at Moravia de Chirripo by John Baker (K.U.M.N.H. No. 31950). The elevation of this point is approximately 580 m. It agrees in most details of squamation with the specimen described from Isla Bonita by me (*loc. cit.*) as well as with the type.

The species has the snout narrowed in front of the eyes, and the sides of the snout are nearly perpendicular to lip. The median dorsal row of scales is enlarged, as are the two adjoining rows and only slightly smaller than the median.

In No. 31950 the ventrals are 166, the subcaudals, 107+ (a small terminal part of tail missing). The anal is single.

The following characters obtain: supralabials, 7-7, the fourth and fifth entering orbit; infralabials, 9-9, two touching the first small pair of chinshields, five touching second enlarged pair; large chinshield of second pair on left side is diagonally severed; third and fourth pairs of chinshields wider than second pair; first labials do not meet behind mental. There are about 19 scale rows on back part of head but elsewhere on body there are 15 rows; eye large its diameter equal to length of snout; maxillary teeth 15, smallest anteriorly and posteriorly; teeth present on pterygoids. The banding is less sharply marked, the intervening lighter areas are pigmented so that the bands seem to be broken laterally. On the venter, the lighter areas are also strongly peppered with brown pigment. The intervening dark areas are broken on venter, only a few forming complete bands; approximately 34 light bands on body and twenty on tail; head lighter with some subsymmetrical dark spots; six dark spots on chin.

The colors are practically the same as in the Isla Bonita specimen described and figured by me (*loc. cit.*).

Dipsas tenuissima sp. nov.

Figs. 28, 29

Type: K.U.M.N.H. No. 31961, approximately 15 km. WSW San Isidro del General, on Dominical Road, in swamp. July 10, 1952; Edward H. Taylor, collector.

Diagnosis: A very slender snake with compressed body, the head much wider than neck; diameter of eye a little less than length of snout; only two pairs of chinshields, first pair separated from mental; nasal partly divided; two preoculars and one loreal enter orbit, the prefrontal being excluded; three postoculars; temporals, 2+3+3. Ventral-subcaudal count, above 300; supralabials, 8-8; infralabials, 9-9. Scale formula, 15-15-15; median scales enlarged, all without keels or pits; 20-21 teeth on maxillary.

Description of the type: Rostral almost twice as wide as high, visible above as a line; internasals relatively large, distinctly wider than long; prefrontals distinctly wider than long, not entering orbit; frontal somewhat triangular in shape, minutely longer than broad, its length equal to or slightly greater than its distance from tip of snout; supraoculars rather small, forming a right angle on inner side; parietals longer than broad, their length less than their distance from internasals; nasal longer than high, with an entrant

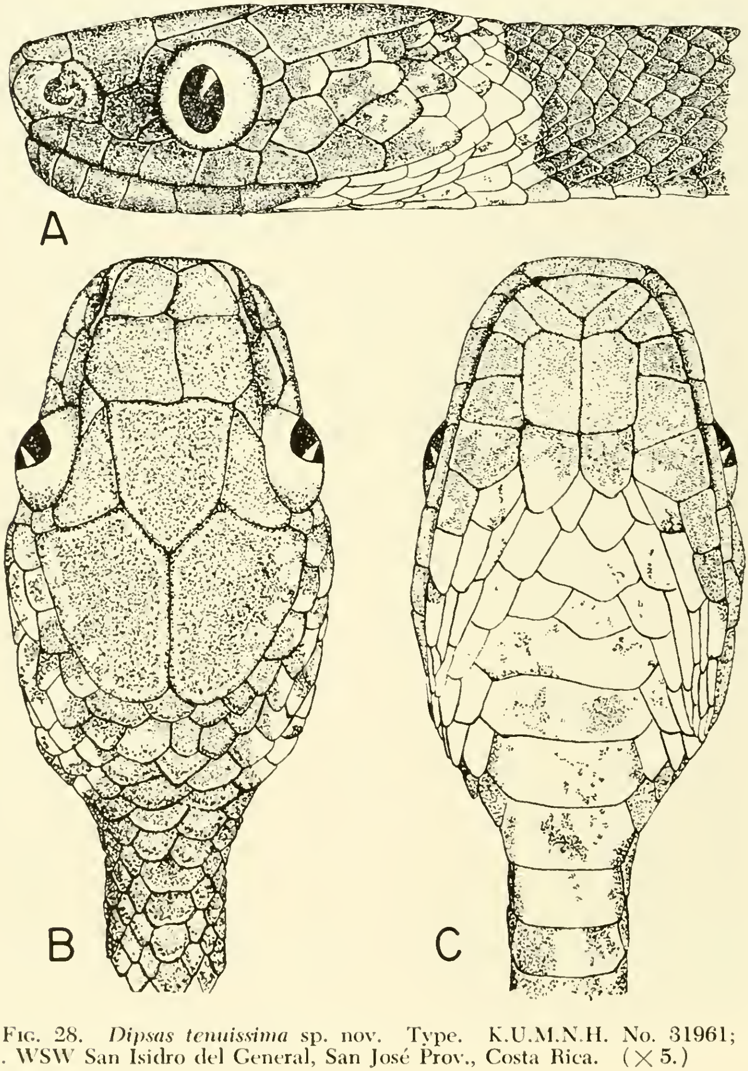

FIG. 28. *Dipsas tenuissima* sp. nov. Type. K.U.M.N.H. No. 31961; 15 km. WSW San Isidro del General, San José Prov., Costa Rica. (× 5.)

suture from internasal to nostril; back rim of nasal scale elevated, with a preceding depression; loreal as high as wide, entering orbit between a large upper and small lower preocular, the upper preocular reaching frontal at a point; eight upper labials, all relatively low, the fourth and fifth entering orbit; three postoculars, the uppermost largest; each anterior temporal touches two postoculars;

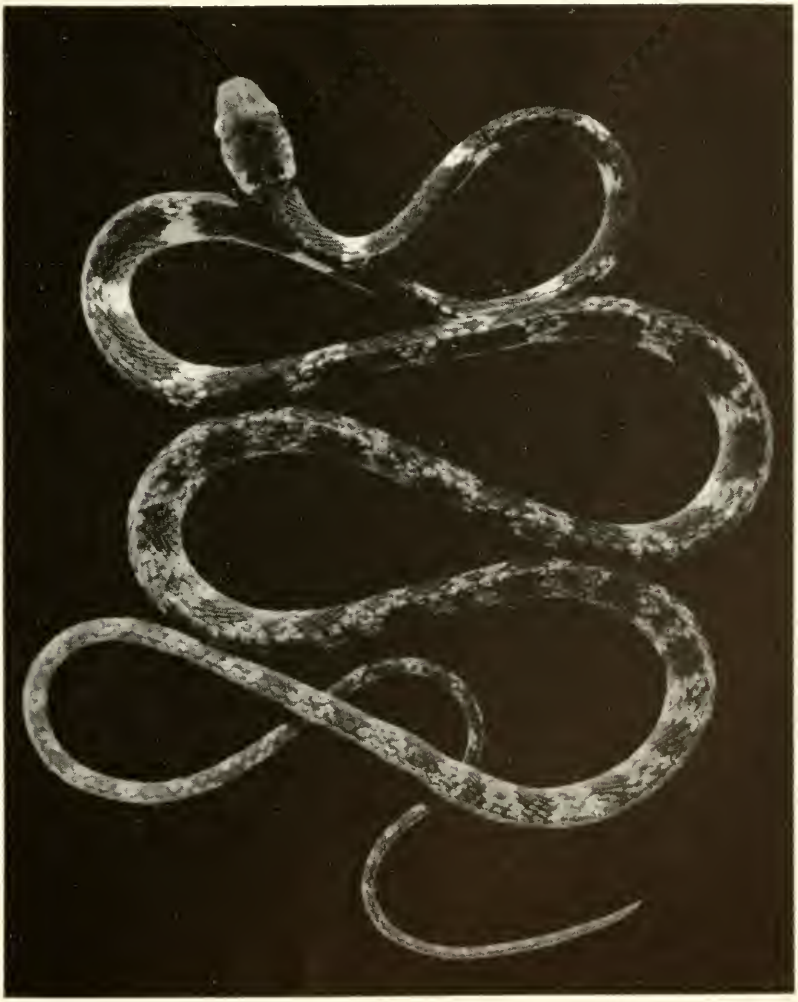

FIG. 29. *Dipsas tenuissima* sp. nov. Type. K.U.M.N.H. No. 31961; 15 km. WSW San Isidro del General, San José Prov., Costa Rica. (Somewhat enlarged; total length, 555 mm.)

temporal formula, 2+3+3; eight infralabials, the first pair forming a median suture, four touching anterior chinshields; latter scales rather truncate anteriorly and posteriorly, not twice as long as wide; second pair smaller in contact.

Scales without keels or paired apical pits, but with microscopic striations; scales about head 19-20 at neck, middle of body, and in front of vent the count is 15. The scales are narrow, pointed, except the median, which is enlarged.

Ventrals, 225; anal single; subcaudals, 128.

Measurements in mm.: Snout to vent, 390; tail length, 165; total length, 555; width of head, 7; length of head to jaw angle, 12.

Micrurus mipartitus multifasciatus (Jan)

Elaps multifasciata Jan, Rev. Mag. Zool., 1858, p. 521 (type locality, Central America).

Micrurus mipartitus multifasciata Taylor, Univ. Kansas Sci. Bull., vol. 34, pt. 1, no. 1, Oct. 1, 1951, pp. 158-159, pl. 19.

Two juveniles of this species were captured at Turrialba, Costa Rica, one, No. 31884, on the farm of the Inter-American Institute of Agriculture, the other, No. 31885, in the edge of the town, at Finca Dominica, crawling across the road.

The former has 58 black bands on body, three on the tail; the latter has 63, with four on the tail. This latter specimen has a discrete black spot on the parietals that is absent in the former. The ventrals are 260, subcaudals, 28; 276½ and 29, respectively.

Micrurus nigrocinctus nigrocinctus (Girard)

Elaps nigrocinctus Girard, Proc. Acad. Nat. Sci. Philadelphia, 1854, p. 226; U. S. Naval and Astronomical Expedition, vol. 2, Zoology; 1855, p. 210, pl. 34 (type locality Taboga Island, Bay of Panamá.)

Micrurus nigrocinctus nigrocinctus, Taylor, Univ. Kansas Sci. Bull., vol. 34, pt. 1, no. 1, Oct. 1, 1951, pp. 160-162, pl. 20.

Two specimens taken in the same area on the road to Dominical, approximately 15 miles WSW of San Isidro del General are referred to this subspecies. (K.U.M.N.H. Nos. 31880, 31881).

These agree generally with the specimen figured by me (*loc. cit.*) and agree also in having several subcaudals undivided; but both have a greater amount of pigmentation on the venter. They have respectively, 16 body, five tail bands, and 15 body and five tail bands; ventrals, 190, subcaudals, 47, the second to eleventh undivided; ventrals 190, subcaudals 47, the third to twelfth undivided.

Micrurus nigrocinctus mosquitensis Schmidt

Micrurus nigrocinctus mosquitensis Schmidt, Zool. Ser. Field Mus. Nat. Hist., vol. 20, 1933, p. 33 (type locality Limón, Costa Rica); Taylor, Univ. Kansas Sci. Bull., vol. 34, pt. 1, no. 1, Oct. 1, 1951, pp. 164-165, pl. 21, text fig. 5.

Numerous specimens of this subspecies are present in the collection. These are K.U.M.N.H. Nos. 30964-30972, 31877-31879, from Turrialba, Costa Rica. Most of these were taken on the farm of the Inter-American Institute of Agriculture.

Older specimens show a greater amount of dark coloring on the red scales and sometimes this may form rather large blotches on the venter.

Most of the specimens have the nuchal black band connecting by a black stripe, with the dark area on the tip of the chin. I found in two specimens a single undivided subcaudal.

Micrurus nigrocinctus alleni Schmidt

Fig. 30

Micrurus nigrocinctus alleni Schmidt, Zool. Ser. Field Mus. Nat. Hist., vol. 20, no. 30, Oct. 31, 1936, pp. 209-211, fig. 25 (type locality Río Mico, 7 mi. above Rama, Siquia District, Nicaragua).

A male specimen of a coral snake, K.U.M.N.H. No. 31886, taken at Los Diamantes, near Guápiles, in the immediate vicinity where two other forms, *Micrurus nigrocinctus mosquitensis* and *Micrurus richardi* Taylor have been taken, is referred to this subspecies.

The specimen has 17 black bands on body, each bordered by two scale rows of ivory yellow and these groups separated by coral red bands of varying width but usually wider than the black bands. The tail has six black bands separated by bands of ivory yellow, three or four scales wide, the edges of the scales outlined in light brown. Where the black and yellow bands meet on the back the black and yellow scales often interdigitate.

The black of the anterior part of the head extends over the snout and the whole of the frontal, with a slight dark line on the adjoining parts of the parietals. The head band of yellow, covers the occiput and the equivalent of one scale-row behind the parietals. Here the dorsal scales are outlined partially in light brown. The black does not pass behind the eye, the two postoculars being light brown and the outer parts of the anterior infralabials being black. Below the posterior yellow supralabials as well as below the posterior infralabials there are gray areas. These seem to be due to pigmentation *below* the scales.

The red areas above have small but distinct black spots on each scale while on the ventrals the black flecks are scattered.

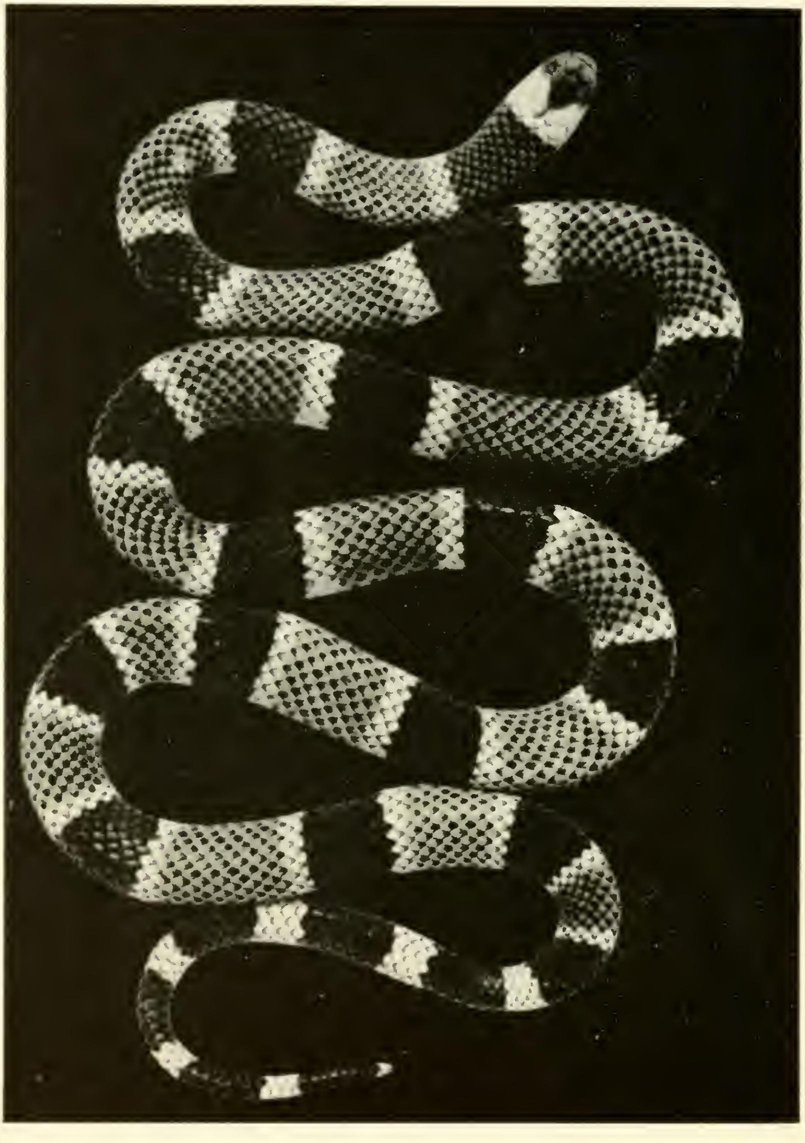

FIG. 30. *Micrurus nigrocinctus alleni* Schmidt. K.U.M.N.H. No. 31886; Los Diamantes, Limón Prov., Costa Rica. (About natural size.)

The ventrals are 224, the subcaudals 56, the anal divided. The scale formula is (17,15),15,15, the scales generally smooth, without "apical pits," those beside vent with keels or rounded knobs.

The number of scales between the black bands are 10-10-13-14-13-10-9-8½-8½-7½-9½-7-5-7½-9½-5. This species has somewhat the general appearance of *richardi* which has 18 black bands on body, 4 on tail. The width of the red and yellow bands together from neck to tail, measured in scale-lengths, are: 17-13-11½-10½-10½-10-10-10-9-9½-9½-9½-10½-10-10-10-10. In *richardi* the head band includes two scale rows. The individual scales on the body are distinctly longer and more acuminate. The parietals are distinctly longer and pointed posteriorly nearly equal to their distance from the rostral. In the species before me the parietals barely reach the internasals. In the type of *richardi* the red of the ventrals have no pigment whatever.

It is possible that certain writers have been too conservative in referring so many forms to subspecific status under the species *M. nigrocinctus.* On the Dominical Road in the Pacific drainage two forms were taken in the same field, *n. nigrocinctus* and *n. yatesi.* At Los Diamantes there are two subspecies occurring, seemingly occupying the same type of terrain, together with a third form which I believe I wrongly associated with *alleni* as a subspecies. Having obtained a specimen of *alleni,* I do not now believe *richardi* stands in subspecific relation to it, but regard *Micrurus richardi* as specifically distinct. Whether *alleni* should remain as a subspecies of *nigrocinctus* or not I cannot say; but the occurrence of this with *mosquitensis* at Los Diamantes argues against their being conspecific. No intergradation is indicated.

Micrurus nigrocinctus yatesi Dunn

Fig. 31

Micrurus nigrocinctus yatesi Dunn. Notulae naturae, no. 108, 1942, p. 8 (type locality, Farm Two, Chiriquí Land Company, near Puerto Armuelles, Chiriquí, Panamá).

A specimen of a coral snake, K.U.M.N.H. No. 31887, from a point on the road to Dominical approximately 15 miles WSW from San Isidro del General, Costa Rica, seems to differ from *Micrurus nigrocinctus nigrocinctus* as does the type of *yatesi.* The specimen has twenty black bands on body (including neck band and four on the tail). The red bands above as well as the yellow bands that separate them from the black bands are largely covered with black so that only a small part of each scale (about one sixth) shows the red or yellow color. Low on the sides and on the ventral surfaces the red is more evident. Each red ventral has a series of black spots often contiguous but obscuring a half or less of the surface; posteriorly the ventral spots are fewer. While there is no red evident either above or below on the tail, in the yellow areas the scales have from one half to two thirds of their surfaces blackened while

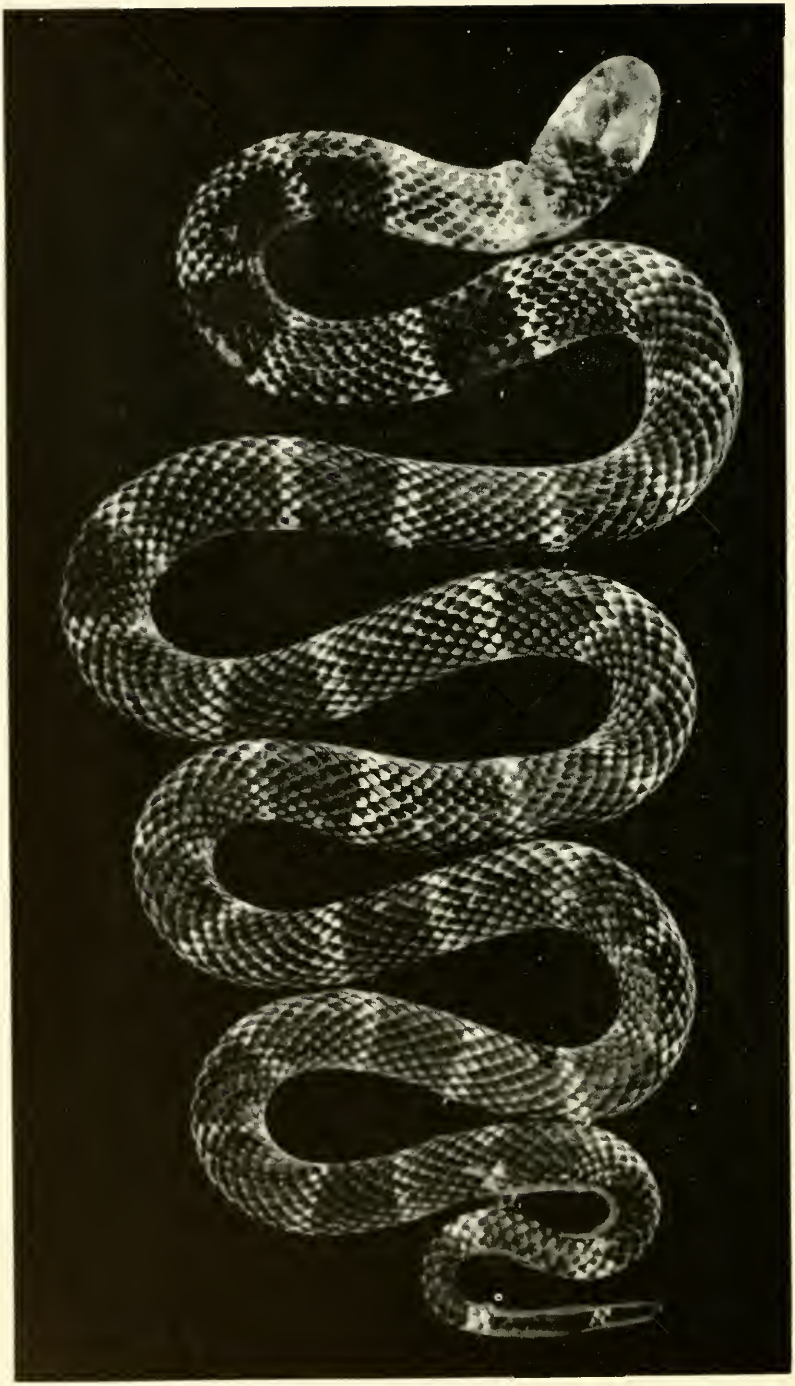

FIG. 31. *Micrurus nigrocinctus yatesi* Dunn. K.U.M.N.H. No. 31887; 15 miles WSW San Isidro del General, San José Prov., Costa Rica.

below they have no or only an occasional black fleck. The head band is almost completely obscured above, with an ivory spot covering the lower parts of the temporals and parts of the last three labials. The mental and the major part of the first three labials are black. Chin ivory with some black flecks.

The ventral count is 225; subcaudals, 38. Total length, 664 mm.; tail, 73 mm.

The wisdom of distinguishing a species or a subspecies on the basis of severed heads is to be questioned. If I have correctly identified this snake with *yatesi* it would appear that the two forms, *yatesi* and *nigrocinctus*, occur in the same locality.

Micrurus pachecoi Taylor

Micrurus pachecoi Taylor, Univ. Kansas Sci. Bull., vol. 34, pt. 1, no. 1, Oct. 1, 1951, pp. 165-168, pl. 22, text fig. 6, (type locality, Guanacaste, Costa Rica).

Two specimens of this species were taken at Tenorio, Guanacaste, K.U.M.N.H. Nos. 31882, 31883, and No. 31888 obtained from Sr. Alfonso Trejos is of unknown provenance in Costa Rica. The first specimen was found dead, with a section of the body, of unknown dimensions, missing. It is a male of somewhat smaller size but agreeing with the type in most characters. There are 52 subcaudals. Immediately behind the vent the tail is narrowed, then widens a half inch back of the vent. There are five black bands on the tail. The supraoculars are relatively wide, the white band on the head does not reach the back of the parietals, and there is a pair of darker spots on the parietals. Five black bands are on the tail. The ventrals, colored red and yellow, only occasionally have darker flecks.

The second specimen (No. 31883) a male, and distinctly younger than the preceding, has the head markings the same, save that the parietal spots are only barely suggested. The scales of the red and yellow bands are lightly and rather evenly pigmented. There are 17 black bands on body (the female type has 22) and 7 black bands on the tail (five in the female type). In neither case is there red on the tail.

There is, however, one rather striking variation in squamation in the second male. The preocular and posterior nasal are separated, permitting the prefrontal to touch the third labial.

The absence of the darker points on the red scales in this specimen is due, I believe, to youth, since in certain other forms this change in amount of dark pigmentation is ontogenetic.

The ventrals are 206; subcaudals, 58; anal, as well as the third and fourth subcaudals divided. The tail seemingly has a rather sharp medial ridge throughout most of its length. This is a little less distinct in the other male, and seemingly not indicated in the female. The scales on the sides above the vent are keeled or with small rounded knobs.

A third Costa Rican specimen of unknown provenance was presented to me by Sr. Alfonso Trejos of the Hospital San Juan de Diós. This specimen agrees with the preceding in most characters. It is a female with 18 body bands, and four bands on the tail.

My specimens were found or captured in open grassy areas near patches of woodland.

Bothrops atrox asper (Garman)

Fig. 32

Trigonocephalus asper Garman, Bull. Mus. Comp. Zool., vol. 8, 1883, p. 124 (type locality, Obispo, on the Isthmus of Darién, Panamá, Dr. Maack, coll.).

Bothrops atrox atrox Taylor, Univ. Kansas Sci. Bull., vol. 34, pt. 1, no. 1, Oct. 1, 1951, pp. 179-180.

Specimens of this species have been acquired from both the Pacific and Caribbean drainages. The following numbers are in the collection: Nos. 34007, from an unknown Costa Rican locality; Nos. 34008-34011, Tenorio, Las Cañas, Guanacaste; Nos. 30963, 30999, 34888, Turrialba.

Scale data on *Bothrops atrox asper*

	Number	*Sex*	*Ventrals*	*Subcaudals (divided)*	*Scale formula*
Tenorio	34007	♀	188	63	27-25-27-27-23-21
	34008	♂	197	68	27-25-27-27-23-21
	34009	♂	197	69	27-25-25-25-19
	34010	♂	199	68	27-25-25-23-19
	34011	♀	199	61	27-25-25-23-21
Turrialba	30963	♂	190	74	27-23-23-25-23-19
	30999	♂	198	66 +	27-25-23-25-23-19
	34888	♀	193	66	27-25-25-25-23-19

Bothrops nummifer nummifer (Rüppell)

Fig. 33

Atropos nummifer Rüppell, Verz. Mus. Senck., Amph., 1845, p. 21 (type locality, Teapa, Mexico).

Bothrops nummifer nummifer Taylor, Univ. Kansas Sci. Bull., vol. 34, pt. 1, no. 1, Oct. 1, 1951, pp. 181.

A young specimen of this species K.U.M.N.H. No. 30959 was collected at the Inter-American Institute of Agriculture, Turrialba, Aug. 31, 1951.

The specimen agrees rather closely with a large adult obtained in 1947 at the same locality. The following characters obtain:

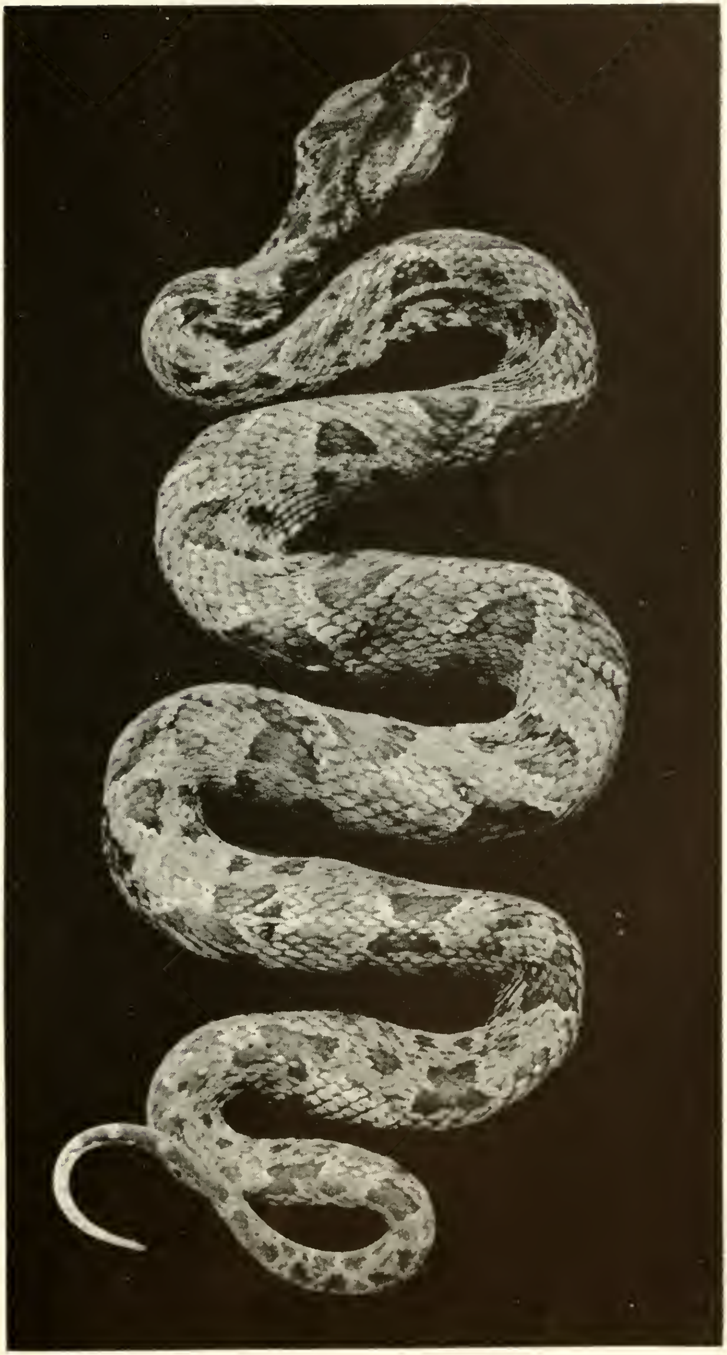

FIG. 32. *Bothrops atrox asper* (Garman) K.U.M.N.H. No. 34009; Las Flores, Tenorio, Costa Rica. (Actual total length, 842 mm.)

rostral separated from nasal by one or two scale rows; nasal divided, the anterior part broken into two scales on one side; on one side, supraocular enlarged; on one side subocular elongate, but broken into two or three scales on the other side; supralabials, 10-10, separated from subocular by three scale rows, from scales surrounding the facial pit by two or three rows; infralabials, 12-12, three touching the anterior chinshields. Scale formula: 31-25-21-19; ventrals, 123;

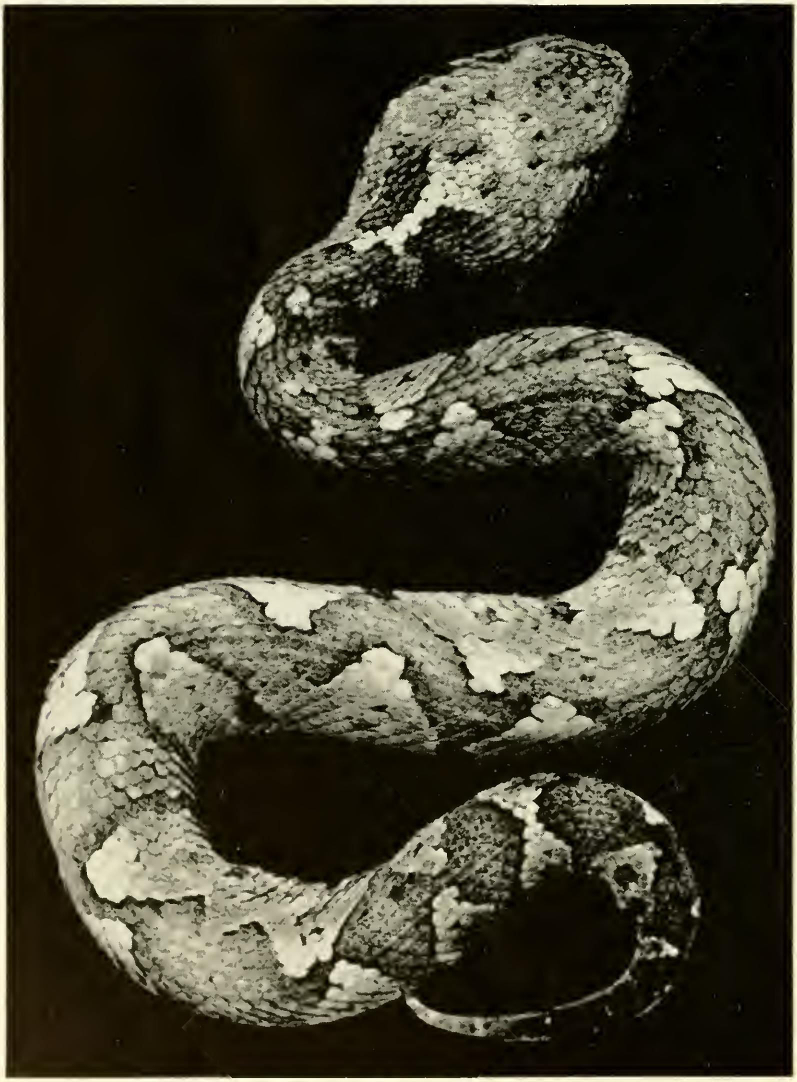

FIG. 33. *Bothrops nummifer nummifer* (Rüppell) K.U.M.N.H. No. 30959. Turrialba, Costa Rica. (Actual total length, 385 mm.)

subcaudals, 34, the first, and subcaudals numbers 27, 28, 30-33 divided; total length, 390 mm.; tail, 48 mm.; head width, 28 mm.; length, 31 mm.

Bothrops picadoi (Dunn)

Trimeresurus nummifer picadoi Dunn, Proc. Biol. Soc. Washington, vol. 52, 1939, pp. 165-168, La Palma, Costa Rica.

Bothrops picadoi Taylor, Univ. Kansas Sci. Bull., vol. 34, pt. 1, no. 1, Oct. 1, 1951, pp. 180-181.

I obtained a specimen of this large species at Turrialba. It is, I believe, the point of lowest elevation at which the species has been taken (624 m.). Its length is 1,040 mm., the tail 104 mm.

The following data obtain: ventrals, 150; subcaudals, 36, none divided; anal single; 10-10 supralabials; 13-12 infralabials, three touching first chinshields; the scale formula is 31-27-25-25-23-21; supraoculars elongate, slender, with ten scales between them; no scales between rostral and nasal.

Bothrops nasutus Bocourt

Fig. 34

Bothrops nasutus Bocourt, Ann. Sci. Nat., ser. 5, vol. 10, 1868, p. 202 (type locality, Pansas, bank of Polochic, Guatemala); Taylor, Univ. Kansas Sci. Bull., vol. 34, pt. 1, no. 1, Oct. 1, 1951, pp. 177-178.

The species was found to be common in the general region about Turrialba, chiefly on the farm of the Inter-American Institute of Agriculture. Specimens are usually terrestrial but are sometimes found in low coffee bushes. Taylor (*loc. cit.*) states that the "body is slender." This may be true of males but the females are thick and all are relatively short. The largest one of my 14 specimens measures, total length, 485 mm.; tail, 52 mm. The specimen figured, from an unknown locality in Costa Rica has the labials and nasals separated by a row of scales. In one Turrialba specimen the first labial is separated on one side only.

All numbers listed are from Turrialba except No. 34005, La Lola, and No. 34636 of unknown provenance.

Table of scale counts of *Bothrops nasutus*

Number	*Sex*	*Ventrals*	*Subcaudals*
30982	♂	141	34
30983	♂	141	34
30984	♀	140	
30985	♂	137	35
30986	♀	138	29
30987	♂	140	36
34005	♂	139	33
34635	♀	139	29
34636	♀	139	26
34637	♀	144	31
34638	♀	138	29
34876	♀	136	31
34879	♀	140½	29
34880	♀	141	31

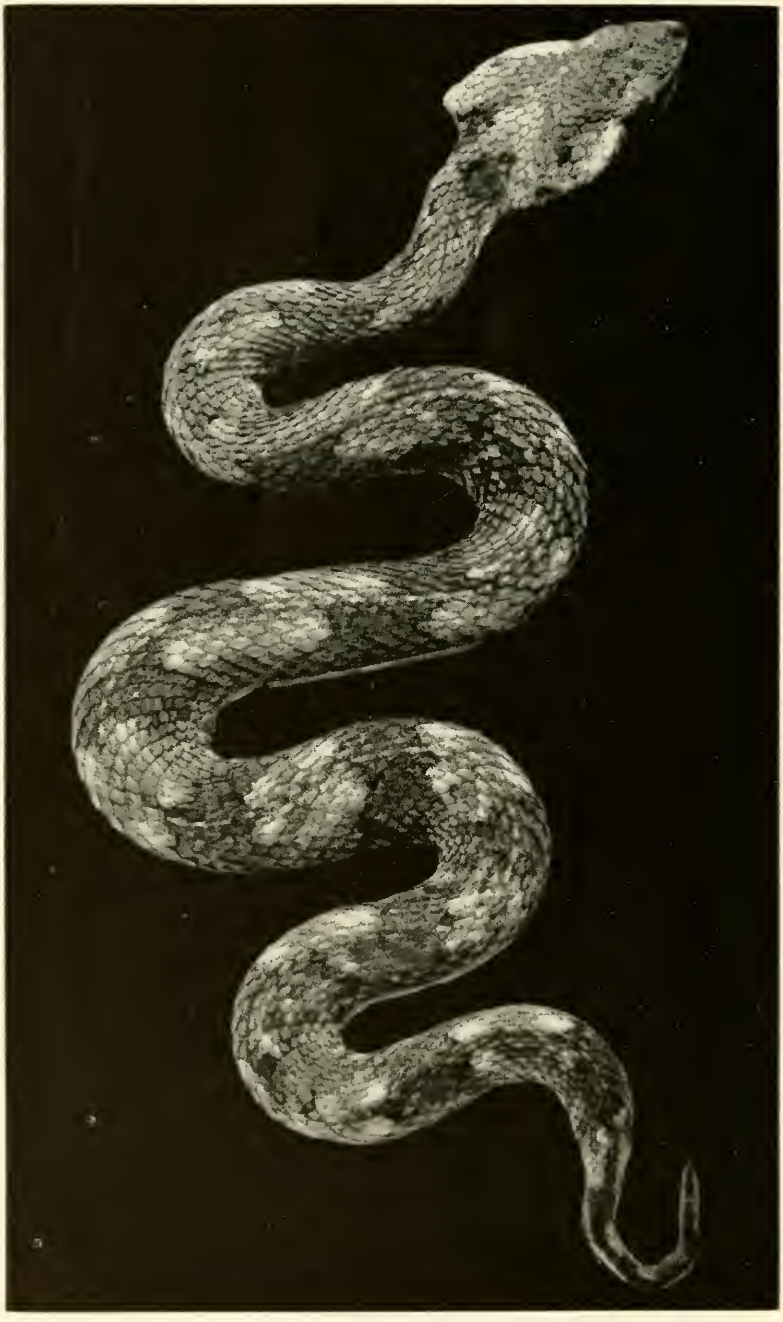

FIG. 34. *Bothrops nasutus* Bocourt. K.U.M.N.H. No. 34636; unknown locality, Costa Rica. (About natural size.)

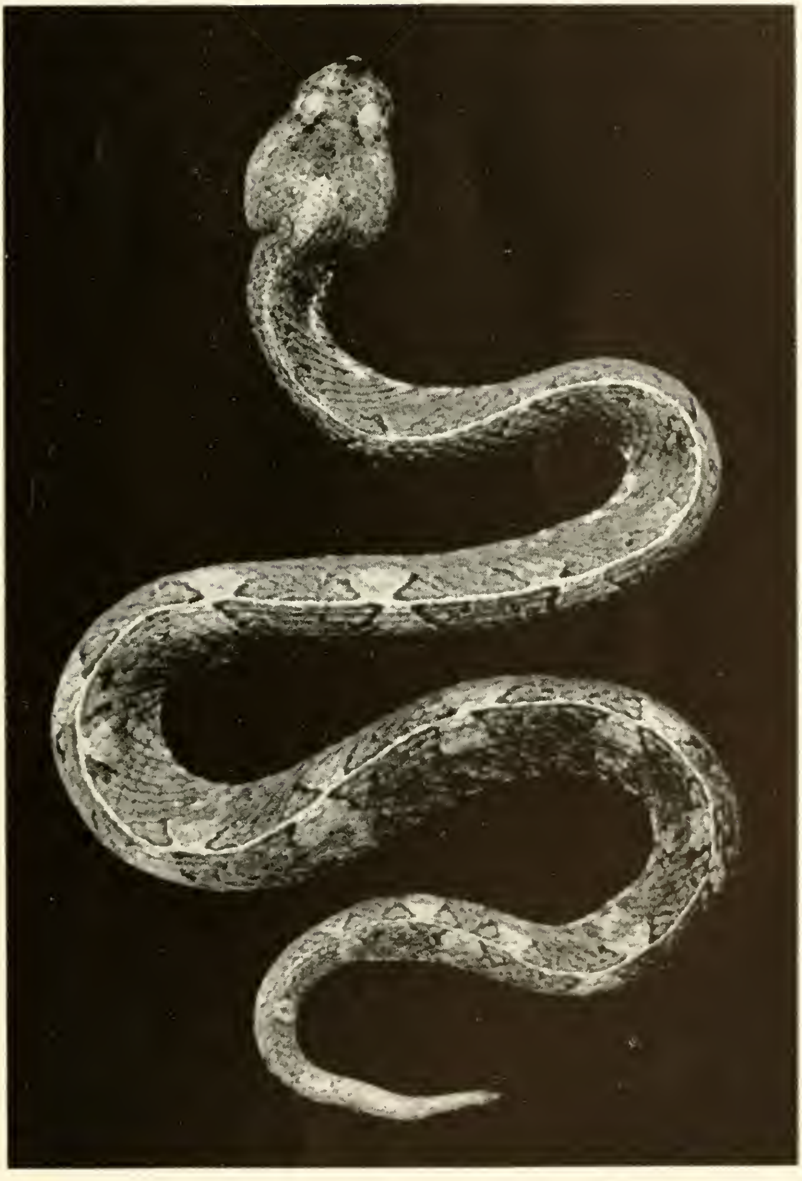

Fig. 35. *Bothrops ophryomegas* Bocourt. K.U.M.N.H. No. 34006; unknown locality, Costa Rica. (Actual total length, 498 mm.)

Bothrops ophryomegas Bocourt

Fig. 35

Bothrops ophryomegas Bocourt, Ann. Sci. Nat., ser. 5, vol. 10, 1868, p. 201 (type locality, west slope of Escuintla Range, Guatemala); Taylor, Univ. Kansas Sci. Bull., vol. 34, pt. 1, no. 1, Oct. 1, 1951, p. 178.

A young living specimen was presented to me by Sr. Alfonso Trejos of the Hospital San Juan de Diós, San José, Costa Rica. The specimen is of unknown provenance, but is presumed to have been sent from the west coast of Costa Rica. The following characters obtain (K.U.M.N.H. No. 34006): rostral distinctly higher than wide, visible above at a point; a pair of diminutive internasals, and somewhat larger supranasals (anterior canthals); a canthal connects this scale with the large upper preocular; canthal line sharp; supraoculars large, separated by six scale rows; about 23 scales on the top of snout; nasal large, divided, the posterior part small, subcircular, its posterior edge elevated somewhat; four small loreals; two rows of scales between the very narrow elongate subocular and the labials; one row between labials and the scales bordering the lateral pit; three preoculars; supralabials, 10-9, the fourth and fifth largest; infralabials, 10-10, four bordering first chinshields, which are larger than second pair; two somewhat enlarged rows of temporals. Scale formula: 25, 21, 21, 19, all except outer row keeled, the scales of the anterior part of body with distinct paired apical pits. Ventrals, 160; subcaudals (single), 42; anal single. A pattern of paired blotches, separated by a median hair-fine white line, with smaller lateral series of spots on the third and fourth scale rows, and a second series of spots on first row that touches the ventrals; venter generally brown, each ventral with two or three lighter areas; a dim light line from below eye to lip, with a second narrow line on the ventral scales below and behind jaw angle.

Bothrops nigroviridis nigroviridis (Peters)

Bothriechis nigroviridis Peters, Monats. Akad. Wiss. Berlin, 1859, p. 278, pl. fig. 4, (type locality, Costa Rica).

Bothrops nigroviridis nigroviridis Taylor, Univ. Kansas Sci. Bull., vol. 34, pt. 1, no. 1, Oct. 1, 1951, pp. 176-177.

A specimen, K.U.M.N.H. No. 31954, from above San Isidro del General (Pacific slope) was obtained from Sr. Lic. Oldemar Chavarría Ch. The exact elevation is unknown.

This specimen, somewhat discolored by preserving fluid, is otherwise in a good state. There are several points in which this specimen differs from the one * listed in my previous review.

Snout rounded anteriorly; nasals separated by a single minute scale; supranasals enlarged, followed by a larger canthal, the two scales with upturned outer edge; canthal touching upper preocular but separated from supraocular by a single scale; supraoculars notched on inner border with an enlarged scale inserted in notch; 7-10 scales between the supraoculars; about 15 scales occupy top of snout other than those mentioned; nasal large, sutured above nostril; eight scales in loreal region, two separating the nasal from upper preocular; pit surrounded by a lower preocular and three other scales, lower one smallest; on right side, subocular fused together to form a very elongate scale; on left side, three suboculars; three postoculars; supralabials, 9-9; infralabials, 10-11, three touching chinshields; anterior chinshields three times size of second pair; scale formula, (25-21), 21, 19, 17, 17; ventrals, 158; subcaudals, 57, first divided, others single; anal entire.

Chin and throat yellow with a very slight suggestion of pigment at certain points on infralabials. Pigment at certain points on supralabials. Scale on side of head with some black flecks. Greatest diameter of pit about four fifths of the eye diameter. Total length, 725 mm., tail, 102 mm.

Barbour and Loveridge (Bull. Antiv. Inst. Amer., vol. 3, no. 1, 1929, p. 2, fig. 1) have separated *Bothrops n. marchi* of Honduras as a subspecies. It may be significant that the ventral-subcaudal count of this female specimen (158, 57) approaches their figures given for *marchi* (158-163, subcaudals 51-63) more than counts given for *n. nigroviridis* (134-146, 49-54) by these authors.

The presence of black markings on the dorsum and head, and the black diagonal stripe behind the eye, distinguish it from *n. marchi.*

Bothrops lateralis (Peters)

Fig. 36

Bothriechis lateralis Peters, Monatsb. Akad. Wiss. Berlin, 1852, p. 674 (type locality, Costa Rica).
Bothrops lateralis Taylor, Univ. Kansas Sci. Bull., vol. 34, pt. 1, no. 1, Oct. 1, 1951, pp. 175-176.

A mutilated specimen of this species was found about seven miles southwest of Villa Quesada, Costa Rica, July 11, 1951. As far as can be discerned the specimen agrees with the characters of the species within the limits of known variation.

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* Through a metathesis of data in cataloguing, this specimen was recorded in the above publication from Isla Bonita. It was actually taken at Boquete Camp on the Pacific slope of Cerro de la Muerte at 5,500 ft. elevation, the collector, Mr. Virgil Cave.

A specimen, K.U.M.N.H. No. 25688, from Santa Cruz, Volcán Turrialba, is figured.

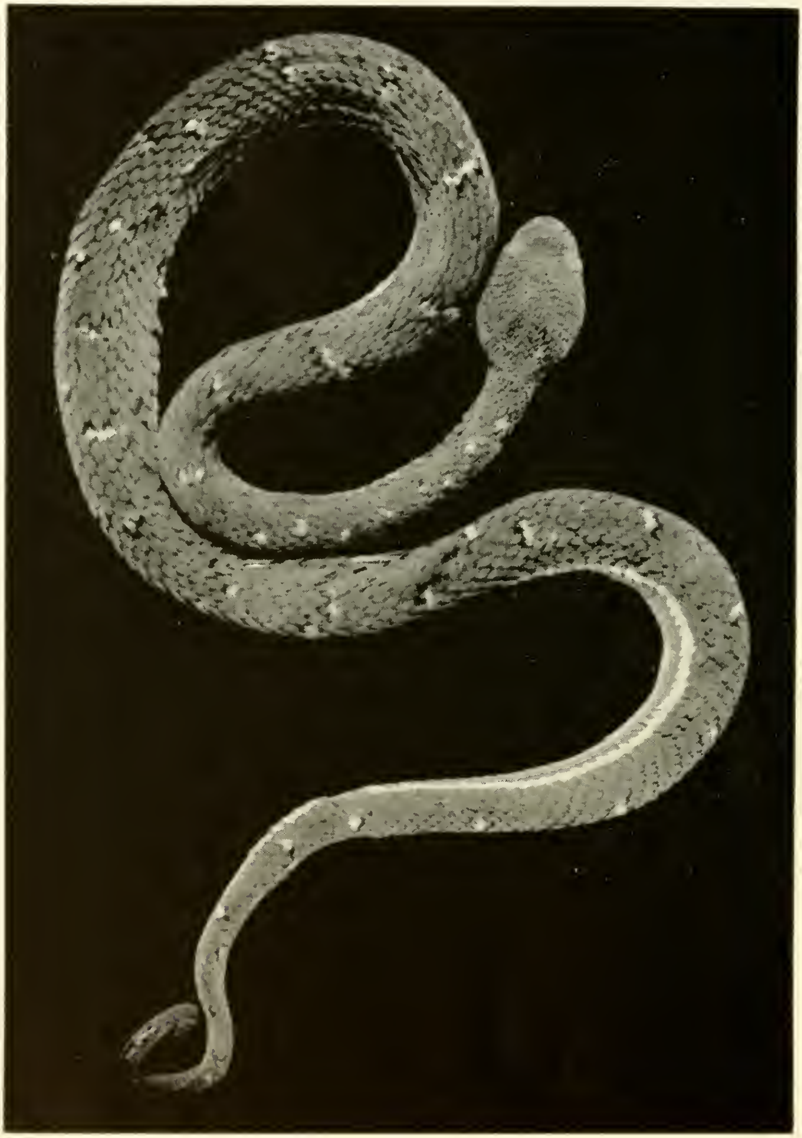

FIG. 36. *Bothrops lateralis* (Peters) K.U.M.N.H. No. 25688; Santa Cruz, Volcán Turrialba, Costa Rica. (Actual total length 603 mm.)

Bothrops schlegelii schlegelii (Berthold)

Figs. 37, 38

Trigonocephalus schlegelii Berthold, Abh. Ges. Wiss. Göttingen, vol. 3, 1846, p. 13, pl. 1, figs. 5-6, (type locality, Colombia).

Bothrops schlegelii Taylor, Univ. Kansas Sci. Bull., vol. 34, pt. 1, no. 1, Oct. 1, 1951, pp. 173-175.

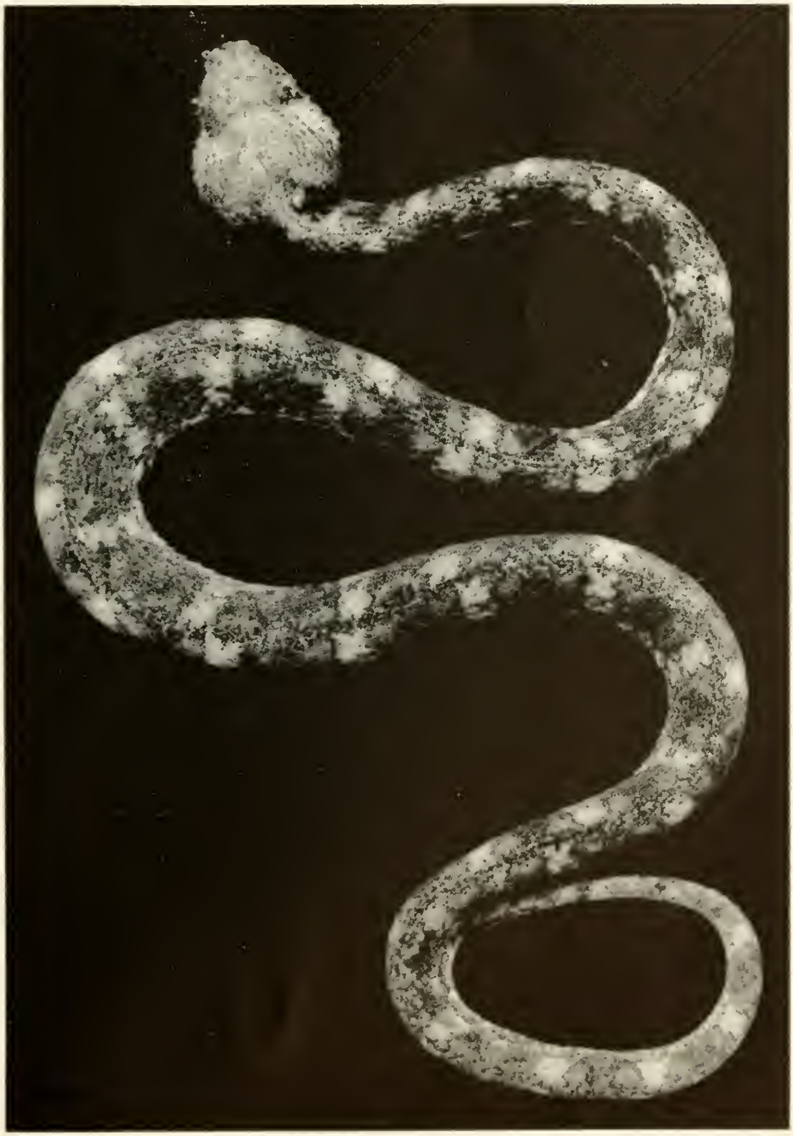

FIG. 37. *Bothrops schlegelii schlegelii* (Berthold). K.U.M.N.H. No. 31999, Turrialba, Costa Rica, young; actual total length, 355 mm.

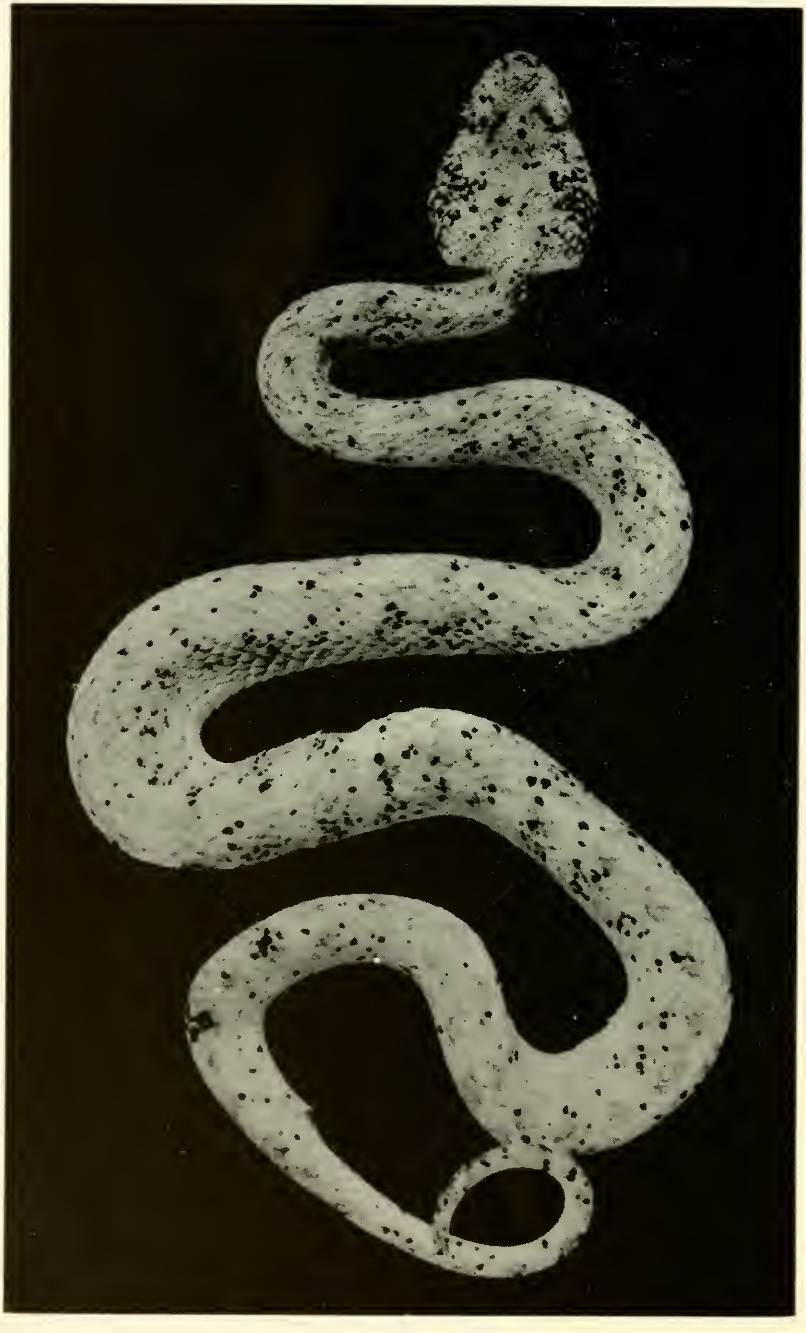

FIG. 38. *Bothrops schlegelii schlegelii* (Berthold). K.U.M.N.H. No. 34002, Costa Rica, Yellow form. *"Oropel";* actual total length, 567 mm.

Several specimens of this puzzling species were acquired. They are from the following localities: K.U.M.N.H. Nos. 30953, 30954, 31999, 34000, Turrialba; Nos. 31996, 31998, San Isidro del General; No. 34003, Tenorio, Las Cañas, Guanacaste; No. 34845, Golfito; Nos. 34001, 34002, 34004, from unknown Costa Rican localities.

The specimen No. 34004 is the largest I have seen, measuring 745 mm. in total length, the tail 117 mm. Specimens from Turrialba have a lower total ventral count than the Pacific drainage specimens. However, this may be largely sexual since most of the western specimens are males.

No. 34002, a specimen of the yellow form is figured. It is Costa Rican but the locality is unknown. The specimen was presented to me alive by Sr. Alfonso Trejos. No. 31999, a young specimen is also figured.

Scale data on *Bothrops schlegelii* (Berthold)

Number	*Sex*	*Ventral*	*Sub-caudals*	*Totals*	*Scale formula*
30953	♀	153	48	201	25-23-23-21-17
30954	♀	155	54	209	25-23-23-21-17
31999	♂	153	56	209	25-23-23-19-17
34000	♀	150	50	200	25-23-23-19-17
31996	♂	164	54	218	25-23-23-19-17
31998	♂	163	58	221	25-21-21-19-15
34003	♂	160	59	219	25-23-23-21-17
34845	♂	166	61	227	25-23-23-21-17
34001	♂	159	61	220	23-23-23-21-17
34002	♂	155	50	205	25-23-23-21-17
34004	♀ ?	156	53	209	25-23-23-21-17

Bothrops schlegelii supraciliaris subsp. nov.

Fig. 39

Type: K.U.M.N.H. No. 31997; mountains near San Isidro del General, San José Province, Costa Rica. Collector and date unknown.

Diagnosis: A subspecies having soft spines above the eye but differing from known forms of *schlegelii* in having two supraoculars on each side, each with small soft, spiny processes; a row of elevated scales border the canthus, subcaudals partly single, partly divided, the latter third of tail orange; most scales of outer row ivory or partly ivory in color, none on second row; chin white, unpigmented; postorbital stripe narrow, bordered above by white. Thirty-seven light, dark edged blotches on dorsal part of body.

Description of type: Front of snout rounding, covered by about 70 strongly keeled scales anterior to level of the supraoculars; rostral approximately as wide as high, not visible above; on canthus a tiny median scale above rostral; each undivided nasal bordered above by three scales with free outer edges; loreal separated from the upper preocular by one small scale; these three scales bordered above by five scales, three of which have the keels strongly elevated into soft flattened "spines" and forming a line with the two elevated supraorbital spines; the supraoculars divided, each bearing one or two small spinelike outer projections; supraoculars separated from the eyes by a row of ten small granular scales; the next row consists of about five scales, two of which are the elevated supraorbital spines, this row separated from orbit by eight or nine small granules, two or three small postoculars; a long narrow subocular runs under orbit to or very close to the lower preocular; three preoculars, the median and lower border pit; second labial separated from lower preocular by a small scale, broadly entering pit and with a scale bordering it above forms the anterior border of pit; the second labial has no partial suture entering from its anterior edge; three to five small lower loreals (prefoveals); 9-10 supralabials, the first continuously bordering the nasal; the third, fourth, fifth, and sixth separated from the subocular by three scale rows; infralabials 12-12, only two of which touch the first chinshields; first pair of chinshields much larger than three following pairs, but distinctly smaller but perhaps a little wider than the first pair of labials; temporal scales keeled strongly, the keels compressed and elevated; about 56 scales across head at angle of jaws; no scales between nasal and rostral.

Scale formula: 25, 23, 23, 23, 19, 19; ventrals (counting from first widened scale), 146; subcaudals 46, anal single; the terminal scute of tail rather large; the tail at tip with six rows of scales; 15 in postanal region; all scales except outer row, and scales on under side of head, keeled.

Color: Bluish to bluish green with a series of 57 dorsal spots of gray fawn, bordered with black; many of the light scales with black dots; blotches occasionally broken and alternate; laterally they reach to third scale row over much of the body; head bluish with a median light black-edged spot on the snout; two diagonal light stripes extend from interorbital region to the temporal region, the edges black dotted; a pair of diagonal occipital light spots; a narrow black streak from eye to jaw angle bordered above by a cream line; chin yellowish white save for olive black marks on the tip of chin and near mouth angle; throat and anterior third of body ivory white with outer edges of ventrals dark olive-gray and a few scat-

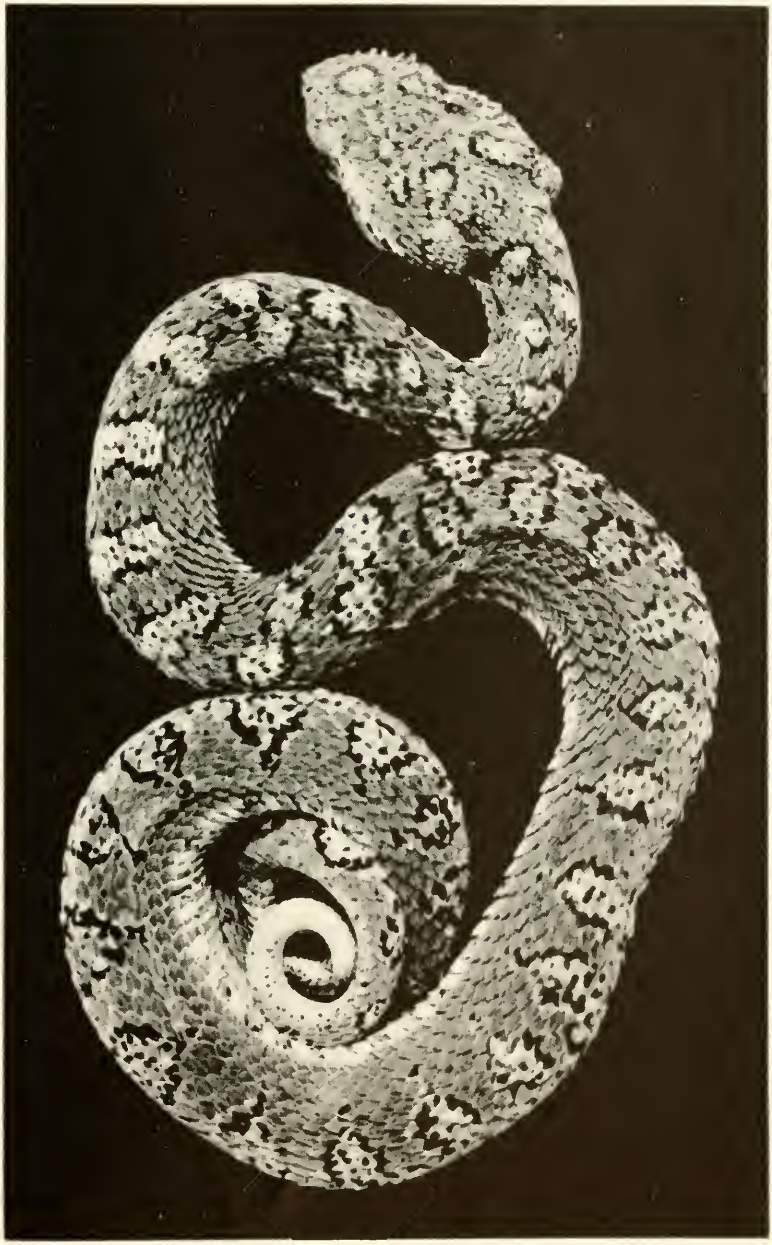

FIG. 39. *Bothrops schlegelii superciliaris* subsp. nov. Type K.U.M.N.H. No. 31997, mountains near San Isidro del General, San José Prov., Costa Rica. (About natural size; actual length, 400 mm.)

tered black dots, which grow thicker until at midpoint the venter is nearly uniformly grayish black, except for some ivory spots under tail. Outer scale row with most of the scales ivory or partly of this color, suggesting a more or less continuous line.

Measurements: Snout to vent 340; tail 60; total length 400; width of head 18; length of head 24.

Remarks: It is not at all certain that this should be regarded as a subspecies of *schlegelii* occurring as it does on the Pacific slope with two color forms of that species.

I first saw this specimen in a collection at San Isidro del General, in 1947, then recently preserved in alcohol by Lic. Oldemar Chavarría Ch. pharmacist of San Isidro del General. In 1952 I obtained it from him through an exchange of specimens. The snake had been brought into the pharmacy by a customer, living in the town but it was caught in the mountains at an unknown elevation. The collector's name was not remembered.

In the collection of Sr. Charvarría were some 20 other herpetological species collected in and about San Isidro del General and El General. I am under deep obligation to him for exchanging this and certain other specimens and for presenting me with several other snakes and lizards as well.

Since both the yellow and dark forms of *schlegelii* also occur in the Pacific drainage, one suspects that this form may be isolated geographically, occupying a higher range on the mountain. A comparison of the two with the present species is warranted.

	Schlegelii schlegelii	*Schlegelii supraciliaris*
Ventrals	160-166	146
Subcaudals	54-61	46
Total count male	218	. .
Total count female	. .	192
Color:	Dark olive with a dorsal pattern of brown spots; dorsolateral small yellow spots. Brown spots with ivory spots on outer row and venter (or yellow).	Blue greeen with light fawn black edged marks
Scale formula at vent reduces to	17	19
Ventrals single	yes	Partly divided (5).
Lateral part of tail	dark	Orange
Supraocular	single	Paired
Canthal scales with soft spines	Not or scarcely indicated.	Strong spines a little less than eye spines in size.
White spotting	Two outer rows	Outer row only, the series nearly continuous.

Crotalus durissus durissus (Linnaeus)

Fig. 40

Coluber durissus Linnaeus, Systema Naturae, Ed. 11, vol. 1, 1766, p. 372 (type locality, designated Jalapa, Veracruz, Mexico, by Smith and Taylor).
Crotalus terrificus durissus Taylor, Univ. Kansas Sci. Bull., vol. 34, pt. 1, no. 1, Oct. 1, 1951, pp. 183-184.

Three young specimens are at hand. Two are part of a litter, born in captivity, and presented to me by Sr. Alfonso Trejos. The third was taken at Tenorio, Guanacaste, Costa Rica. These are K.U.M.N.H. Nos. 31916, 31917, and 31918 respectively. The color pattern is indicated in the figure here given. The scale variations are indicated in the following table:

No.	*Supralabials*	*Infralabials*	*Scale formula*	*Ventrals*	*Subcaudals*
31916	15-15	16-14	31-27,23,17	173	32
31917	16-15	15-16	31-25,23,19	172	32
31918	14-14	14-16	31-27,25,23,19	170	34

The conformation of the head scutes are almost identical in the three specimens as is the color pattern. In all, the first, fourth, and last supralabials are the largest. The first subcaudal is divided in one, the last divided in two specimens.

Details of the head squamation of No. 31918 follows: Internasals large, quadrant-shaped, their length but slightly less than prefrontals; latter a little wider than long, their back edges thickened and somewhat tubercular; the interorbital area occupied by five scales, a larger regular anterior pair, a smaller posterior pair, with a small intercalated scale between the four; supraoculars very large with a small "parietal" back of supraocular separated from its fellow by two small scale rows. Two small scales between large postseminasal and the supraocular; two large preoculars, the lower with two other scales surround the pit; two loreals; six small scales in front of pit; three below it. Preseminasal larger than the postseminasal; one post- and three suboculars (2 post-, 4 suboculars). Two scale rows between labials and suboculars.

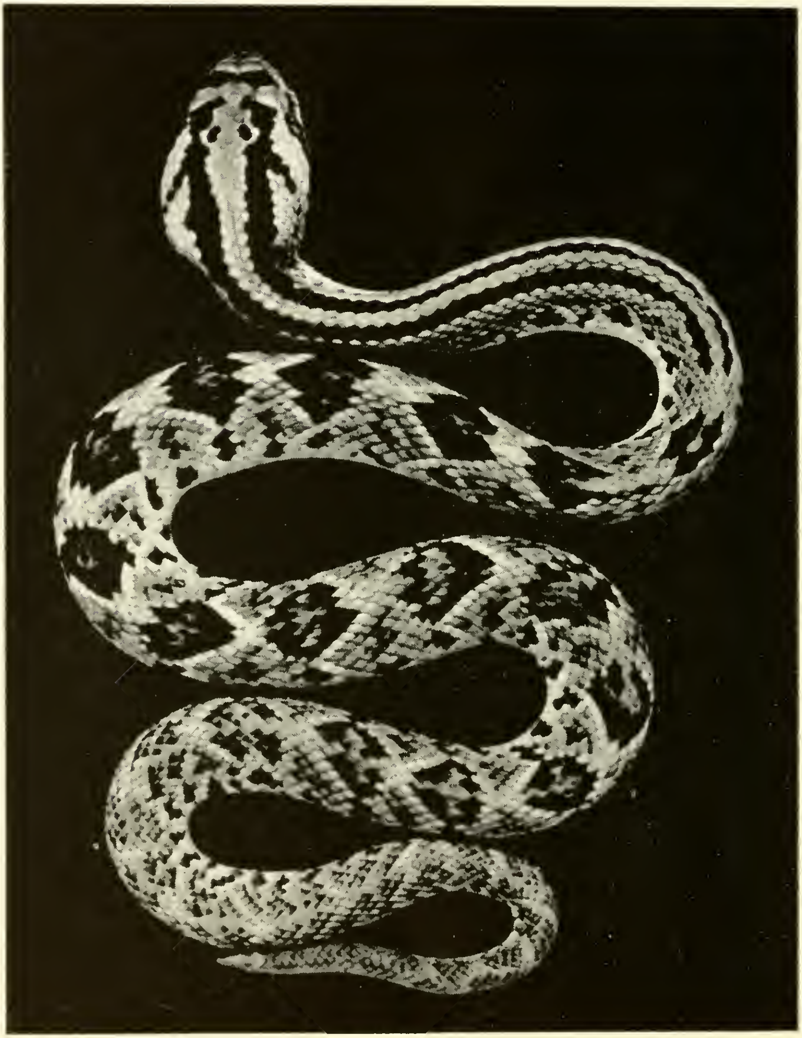

FIG. 40. *Crotalus durissus durissus* (Linnaeus). K.U.M.N.H. No. 31918; Tenorio, Las Cañas, Guanacaste Prov., Costa Rica. (Total length, 417 mm.)

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ERRATA

Univ. Kansas Sci. Bull., vol. 34, pt. 1, no. 1, Oct. 1, 1951.

(This number went through press while I was in Costa Rica and was not adequately corrected and proof read.—E. H. T.)

Page 5, line 11, for "*sp. nov.*" read "*subsp. nov.*"

Page 20, line 25, for "Neoparias" read "Neopareas," also p. 37, line 34; p. 66, lines 4, 5, 6, 10, 11, 12.

Page 21, line 44, for "*serperastra*" read "*serperaster*"; also p. 11, line 26, and lines 37, 38.

Page 24, line 14 for "L'iconographie" read "Iconographie."

Page 30, line 35, for "*Nothopis*" read "*Nothopsis.*"

Page 31, line 7, for "Morehead" read "Morehouse," also p. 32, line 1; p. 43, line 31; p. 63, lines 11, 18; p. 64, line 2; p. 107, line 27; p. 109, line 9.

Page 33, line 39, for "*rugosa*" read "*rugosus*"; also p. 34, line 1.

Page 35, line 13 for "Hemicognathus" read "Henicognathus."

Page 38, line 28 for "15 rows" read "15 or 17 rows."

Page 39, line 22 for "Calophrys" read "Colophrys."

Page 43, line 22, for "dolichocephalus" read "dolichocephalum."

Page 51, line 9 for "at" read "et."

Page 56, line 3, insert "p. 216" after "1910."

Page 72, line 18, for "4 scale pits" read "2 scale pits" and delete following ten words.

Page 81, line 13, for "1391" read "1931."

Page 84, line 37, insert "1854" at beginning of line.

Page 86, line 13, for "Equador" read "Ecuador."

Page 92, line 32, for "one species is" read "two species are."

Page 97, line 9, for "row" read "rows."

Page 118, line 19, delete, "?".

Page 122, line 2, after "vol. 31" insert "Dec. 23, 1893, p. 347"; delete "333"; line 27, for "Tail blackish red, spotted" read "tail blackish, red spotted."

Page 125, line 11, for "Leptodeira" read "Leptodira"; also 126, line 2.

Page 134, line 3, for "the region about Turrialba" read "Isla Bonita."

Page 142, between line 34 and line 35 insert "pl. IV, fig. 1."

Page 149, line 1, for "strips" read "stripes."

Page 154, line 18, for "1873" read "1872."

Page 172, line 30, for "Barsiliensium" read "Brasiliensium."

Page 176, for "Isla Bonita at about 5,500 ft. elevation" read "San Isidro del General."

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Speciation and Distribution of the Crayfishes of the Ozark Plateaus and Ouachita Provinces[1]

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[1] Submitted to the Department of Zoology and the Faculty of the Graduate School of the University of Kansas in partial fulfillment of the requirements for the degree of Doctor of Philosophy.

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ABSTRACT: The crayfish fauna of the mountainous provinces of southern Missouri, extreme southeastern Kansas, northern and west-central Arkansas and east-central Oklahoma is considered in this paper. Three genera (*Procambarus, Orconectes, Cambarus*) belonging to the subfamily Cambarinae occur in this region, and they are represented by a total of thirty-one known species and subspecies. The relationships of these forms as shown by morphologic characters and by geographic distribution are discussed.

The region is dominated by an endemic crayfish fauna, and is invaded incompletely by widely ranging species from surrounding areas. The genus *Orconectes,* particularly the *hylas* group, has diversified strikingly within the region. Four centers have developed which contain more than one endemic species of crayfish. Moreover, the *hylas* group, which contains eleven species and subspecies, presents a remarkably complete phylogenetic assemblage. The entire regional fauna shows definite relationships with the fauna to the east of the Mississippi Embayment.

Ecological parallels have evolved in all three of the genera present in the region. The chief parallels are exhibited in the secondary burrowers which live under rocks in streams.

Short descriptions of the species are accompanied by synonymics, illustrations of recognition characters, discussions of variations, maps showing distributions, ecological notes, known ranges, and lists of localities from which specimens have been examined. Some caves in southern Missouri are briefly redescribed.

Speciation and distribution of the forms are discussed by genera, sections and groups. A general discussion of faunal and ecological considerations and a group of concluding statements are given at the close of the paper.

INTRODUCTION

The information contained in this study is the outgrowth of an investigation of the crayfishes of Kansas which was begun in 1946. The results of this preliminary study indicated that the answer to some of the distributional peculiarities of the crayfish fauna of Kansas might lie to the east in the Mississippi Valley, and more particularly in the region to the southeast of Kansas. Accordingly, the

Ozark Mountains territory of southern Missouri and northern Arkansas was chosen as a region for study. Subsequently the Ouachita Mountains region of Arkansas and Oklahoma was added to the field of study. The crayfish fauna of these two physiographic units was surveyed. Extensive field work in these regions was done in the summer of 1948, and the results of that field work combined with data from other collections and the findings of previous workers is contained in this paper.

Scope of the problem: The problem under consideration consists broadly of five major components. These are: (1) a clarification of the systematic position of the crayfishes of the Ozark Plateaus Province and the Ouachita Province; (2) illustration of diagnostic characters for all of the species occurring in these provinces; (3) illustration of the geographic ranges of the species under consideration; (4) an attempt at explanation of the present distribution of the species; and (5) notes on the ecology and life history of the species under consideration.

At the outset the inadequacies of certain aspects of the present study should be mentioned. Since these provinces were incompletely surveyed by earlier workers, crayfishes from the whole region needed to be collected. The data presented on distribution, life history and ecology are perhaps seasonally biased since nearly all of the field work was done in late summer. The cave faunas, especially in northern Arkansas, have not been adequately surveyed, and the distribution of primarily burrowing species is almost certainly not adequately shown. The latter is due principally to the difficulty encountered in collecting these species.

Great opportunity for systematic work in this region still remains, and more adequate collections in the future will without doubt enhance our knowledge of this provincial fauna. However, the broad outlines of faunal relationships are judged to be reasonably complete.

Crayfishes in North America: The crayfishes of North America have been ably treated by a number of investigators. The most outstanding of these authors have adequately abstracted the literature bearing on their studies, but the more comprehensive works deserve special attention as a part of the introduction to a study such as the present one.

Erichson (1846) published a monograph of the entire genus *Astacus* in which he treated the species from the United States now contained in the genus *Cambarus*. Girard (1852) revised the North American Astacidae; he was the first worker to use the name

Cambarus with full generic rank. The first truly monographic work on North American crayfishes was done by Hagen (1870); previous work was thoroughly reviewed, new species were described, taxonomic relationships of the species were discussed, and a careful assessment of the ranges of the species treated was given. However, the real basis for modern work on the genus *Cambarus* is found in Faxon's "Revision of the Astacidae" (1885). Faxon reviewed the work of his predecessors, described new species, gave a detailed account of the distribution of the species, and formulated a system which showed the relationships of the species as he understood them. Faxon followed this monographic work with a series of papers published between the years 1885 and 1914 in which he added to the list of known species and supplied additional locality data on the known kinds. His 1914 paper included a catalogue of the known species of *Cambarus*. Harris (1903) published an ecological catalogue of the species belonging to the genus *Cambarus* in which voluminous detail on distribution was given. Around the turn of the century Ortmann published a number of classical works on fresh-water decapods. Among these papers (1905) was the first truly phylogenetic treatment of what is now known as the subfamily Cambarinae. In this paper Ortmann discussed the systematic and geographic relationships of the several groups in the subfamily. He somewhat modified his views concerning these relationships in a subsequent paper (1931). Eleven years later Hobbs (1942) made a revision of the subfamily Cambarinae in which he thoroughly reviewed the status of the several groups of North American crayfishes which had been recognized by his predecessors, proposed that the genus *Cambarus* be split into six genera (*Procambarus, Troglocambarus, Paracambarus, Cambarellus, Orconectes* and *Cambarus*), and included a catalogue of the species that had been described since 1914.

Subfamily Cambarinae: The family Astacidae as recognized by Faxon (1885b:1) and as revised in part by Hobbs (1942a:338) includes all of the fresh water crayfishes of North America and Eurasia. The Astacidae are related to the Homaridae or marine lobsters. Hobbs (1942a:338) recognized two subfamilies within the family Astacidae; these are the Astacinae and the Cambarinae.

The subfamily Cambarinae includes all of the crayfishes which occur in Cuba, Guatemala, Mexico, and in the United States east of the Rocky Mountains. One cambarid (*Cambarus clarkii*) has been successfully introduced into southern California. The subfamily Astacinae includes all of the crayfishes occurring west of the Rocky Mountains in America north of Mexico, and in Europe and Asia.

The Cambarinae differ from the Astacinae mainly in the absence of gills from the last thoracic somite, and in the absence of a bilobed lamina on the podobranchiae of the fourth pair of pereiopods.

Historical: An historical review of the literature dealing with the crayfishes of the Ozark and Ouachita regions must be prefaced by mention of Hobbs' (1942) generic revision of the subfamily Cambarinae. Prior to this revision an array of generic and subgeneric designations were used which are meaningless to the modern reader unless he is familiar with Hobbs' work. Six genera of crayfishes of the subfamily Cambarinae are now recognized. Four of these genera occur in or around the area under consideration in this paper. These genera are *Procambarus, Cambarellus, Orconectes* and *Cambarus.* The following account contains many references to the names *Cambarus* and *Faxonius* which are superseded today in whole or in part by the four generic names recognized above.

The first records of crayfishes from the region of the Ozarks are contained in Hagen's paper published in 1870. Hagen listed *Cambarus acutus* Girard (p. 37), *C. virilis* Hagen (p. 64), *C. juvenilis* Hagen (p. 67), *C. bartonii* (Fabricius) (p. 76) and *C. obesus* Hagen (p. 102) from Missouri, and *C. obesus* Hagen (p. 82) from Arkansas. Faxon (1885a) described *C. medius* (p. 121) and *C. harrisonii* (p. 130) from Missouri. He later (1885c) published a list of locality records for a number of species occurring in Missouri and Arkansas, but these were discussed more fully in his "Revision of the Astacidae" (1885b).

In his revision (1885b) Faxon recorded *C. bartonii* (Fabricius) (p. 61) as questionably from Missouri, mentioned *C. medius* Faxon (p. 107), *C. harrisonii* Faxon (p. 94) and *C. immunis* Hagen (p. 99) from Missouri, added localities for *C. rusticus* Girard (p. 110) from Arkansas, and added localities for *C. virilis* Hagen (p. 96) from Missouri and Arkansas. Later (1889:237) he described *C. setosus* from a cave in Jasper County, Missouri, and repeated this account in 1890 (p. 625). In this same paper he gave additional localities for *C. virilis* Hagen (p. 630) in Missouri, and described *C. hylas* from Missouri.

In 1894 (p. 1042) Meek described *C. faxonii* from Arkansas. Faxon (1898) supplied further information on species and distribution in the Ozark region giving records of *C. diogenes* Girard (p. 650), *C. lancifer* Hagen (p. 651), and *C. palmeri* Faxon (p. 655) from Arkansas; records of *C. neglectus* Faxon (p. 652), and *C. rusticus* Girard (p. 658) from Arkansas and Missouri; records of *C. virilis* Hagen (p. 652) from Arkansas, Missouri and Oklahoma; and a record of *C. gracilis* Bundy (p. 649) from Missouri. In addition, Faxon described *C. longidigitus* (p. 653) and *C. meeki* (p. 657) from Arkansas; *C. difficilis* (p. 656) from Indian Territory [Oklahoma] and Arkansas; and *C. palmeri longimanus* (p. 655) from Indian Territory [Oklahoma].

Following these papers Harris (1902:8) reported *C. neglectus* Faxon and *C. rusticus* Girard from Missouri. Steele (1902) published a study on the crayfishes of Missouri in which she discussed *C. blandingii* (Harlan) (p. 8), *C. hayi* Faxon (p. 8), *C. gracilis* Bundy (p. 9), *C. bartonii* (Fabricius)? (p. 15), *C. setosus* Faxon (p. 16), *C. diogenes* Girard (p. 20), *C. harrisonii* Faxon (p. 24), *C. immunis* Hagen (p. 25), *C. rusticus* Girard (p. 28), *C. medius* Faxon (p. 31), and *C. virilis* Hagen (p. 32). *Cambarus ayersii* (p. 18) and *C. whitmani* (p. 24) were described as new species. Steele added some new locality records, but most of her distributional data were taken from the literature. Harris published an exhaustive report of the known records of all species of the genus *Cambarus* in 1903. Ortmann (1905:134) gave locality data for *C. palmeri longimanus* in Oklahoma. Faxon later (1914) recorded new localities for *C. simulans* Faxon (p. 365) in Arkansas and Oklahoma, *C. blandingii acutus* Girard (p. 367) and *C. clarkii* Girard (p. 358) from Arkansas, and *C. neglectus* Faxon (p. 375) from Missouri.

Following Faxon's last published work a considerable period of time elapsed before Creaser (1931) described *C. hubbsi* (p. 4) and *C. peruncus* (p. 7) from Missouri. Later (1933) he described *Faxonius punctimanus* (p. 1), *F. luteus* (p. 7) and *F. quadruncus* (p. 10) from Missouri; and *F. menae* (p. 5) from Arkansas. In this same paper Creaser redescribed *Faxonius immunis* as two subspecies and gave locality records for the two forms. Creaser and Ortenburger (1933) gave new locality records from Oklahoma for *Cambarus neglectus* Faxon (p. 37), *C. nais* Faxon (p. 37), *C. immunis* Hagen (p. 38), *C. longimanus* Faxon (p. 38), *C. difficilis* Faxon (p. 39), *C. clypeatus* Hay (p. 40), *C. diogenes* Girard (p. 40), *C. setosus* Faxon? (p. 41), *C. blandingii acutus* Girard (p. 41), *C. simulans* Faxon (p. 42), and *C. gracilis* Bundy (p. 43). Creaser

(1934:5, 7) mapped further locality records for *Faxonius hylas* Faxon, *F. medius* Faxon, *F. harrisonii* Faxon, *F. peruncus* (Creaser) and *F. quadruncus* Creaser in Missouri.

More recently Hobbs (1948a:139) described *Orconectes marchandi* and *O. leptogonopodus* from Arkansas, and (1948b:230) mentioned specimens of *Cambarus fodiens* (Cottle) from Arkansas. Hobbs (1950:194) described *Procambarus tenuis* from Oklahoma and Arkansas, and Hubricht (1950:17) mentioned an undescribed species of *Cambarus* from a cave in Missouri. Finally, Williams (1952) described six new orconectids from Arkansas, Missouri and Oklahoma.

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DESCRIPTION OF THE REGION

The region under consideration in this study is a roughly parallelogram-shaped area in Arkansas, Kansas, Missouri and Oklahoma with its base line running along the western edge of the Mississippi Embayment in Missouri and Arkansas in a NE-SW direction. The region includes southern Missouri, northern and central Arkansas, extreme southeastern Kansas, and northeastern and east central Oklahoma. This region can be divided into two provinces, the Ozark Plateaus Province and the Ouachita Province.

Feneman (1938:631 and ff.) gives the following general description of the Ozark Plateaus. "An area of 40,000 square miles west of the Mississippi River and south of the Missouri consists of plateau, variously dissected and surrounded by lowlands. The form is that of an asymmetrical dome steeper on the east than on the west and breaking off rather abruptly on the south. On that margin, in Arkansas and Oklahoma, the dome form is impaired by the presence of a higher plateau 200 miles in length and averaging 35 miles in width, which rises abruptly some hundreds of feet above the rest. This plateau, known as the Boston Mountains, exceeds 2,000 feet in altitude. The horizon at the top of the dome in Missouri is 1,500 to 1,700 feet high and declines to 400 feet or more on the east and 1,000 feet on the west.

"As the region is one of strong rocks and generally submature dissection, much of it is too steep for farming and remains in forest."

Four principal subdivisions of the Ozark Plateaus Province are commonly recognized.

St. Francois Mountains: At the eastern edge of the dome about 30 miles from the Mississippi River is an area where Pre-Cambrian igneous rocks are partially exposed. Most conspicuous within this area are the St. Francois Mountains in which are exposed rocks of igneous origin.

Springfield Plateau: "The name Springfield Plateau is applied to that part of the Ozarks which is underlain by rocks of Mississippian age." This area is roughly L-shaped with the upright portion of the "L" forming the western extension of the dome, with the heel of the "L" bounded on the west by the Neosho River in northeastern Oklahoma, and with the foot of the "L" extending eastward encompassing the southern drainage of the White River, terminating at the confluence of the White and Black Rivers in eastern Arkansas. The upright portion of the "L" is bounded on the west by the Prairie

Plains which cover eastern Kansas, north central Oklahoma, and invade west central Missouri south of the Missouri River.

Salem Plateau: "In a geographic sense the term Salem Plateau is applied to the Ozark surface where [it is] carved on Ordovician and older rocks, including isolated patches of younger sediments and excluding the St. Francois Mountains." This area lies to the east and north of the L-shaped Springfield Plateau.

Boston Mountains: South of the Springfield Plateau in Arkansas lies a dissected plateau, 200 miles long with an average width of 35 miles, which is known as the Boston Mountains. This feature is capped by Pennsylvanian sandstones and is highest in the middle third where the elevation is about 2,250 feet. Drainages to the north of this feature flow into the White River, those to the south flow into the Arkansas River.

The Ouachita Province consists of two major sections, the Arkansas Valley and the Ouachita Mountains, both of which lie south and west of the Boston Mountains.

"The Ouachita Mountain section is a lens-shaped area having a width of 60 miles and a length of 225 miles from Little Rock, Ark., to Atoka, Okla." It is bounded on the north by the Arkansas River Valley, in part on the west by the Choctaw Fault in Oklahoma, on the east by the Mississippi Embayment, and on the south by the edge of the Coastal Plain. "It is essentially coextensive with a closely compressed and faulted anticlinorium so far as that structure is exposed to view. . . . The entire area consists either of mountains, intermontane valleys or piedmont from which mountains have been carried away by erosion." The summit level near the center of the area on the Arkansas-Oklahoma line reaches a height of 2,600 feet.

The Arkansas Valley is in large part composed of a lowland lying between low sandstone ridges.

MATERIALS AND METHODS

Field equipment: The equipment used in making this study consisted of a seine fourteen feet long made of knotted webbing ⅜ inch on the bar, a short-handled fine-meshed dip net with a spring steel rim, a short-handled fine mesh dip net with a stiff rim, two shovels, a large supply of quart and half-gallon glass-top Mason jars half filled with a five percent solution of formalin, forked sticks, hip boots and tennis shoes for wading in streams and ponds, and bags with shoulder straps for use in carrying jars.

Records: The records kept in the field consisted of three parts: (1) a field catalogue in which was recorded the field number, date, locality, water and bottom conditions; (2) jar tags which were provided with blanks for field number, date, locality and collector; (3) a daily journal.

These three sets of records served as a cross check on each other and as an index to the field collections. Each collection was given the same field number in both the field catalogue and on the jar label. The field numbers ran consecutively.

Methods of capture: Nearly all of the species of crayfishes which occur in the Ozark and Ouachita Provinces inhabit swift, clear, rocky streams. Most of these streams are shallow enough that collecting with a short-handled dip net is the easiest method of capture. Most of the species live under rocks or in shallow burrows under rocks. Some of the species live in deep, muddy-bottomed pools. In any case, collection with a dip net is the most successful method of capture provided the water in the stream is clear.

Some of the small species which I have called collectively "rock crawlers" are usually found in gravel on shoals in swift water, in the water near the border of the stream, or under rocks well seated in mud or sand. Some of these species have a coloration which nearly matches that of the stream bed. These species are easily overlooked unless the collector is careful in his work.

Experience has shown that crayfishes can be maneuvered into a dip net with the aid of a dark colored stick with practically no resistance on the part of the crayfish. Sticks with the bark freshly removed or the bare hand of the collector are not so successfully employed. Apparently crayfishes are used to seeing sticks in the water and are not disturbed even when these sticks push them around.

The rockiness of a majority of the mountain streams in this region makes the use of a seine impractical. Deep pools with few rocks on the bottom can be successfully seined, and muddy ponds or ditches must necessarily be seined. Experience has shown that in the case of muddy situations, several sweeps of the seine over the same area are usually profitable. Agitation of the water apparently brings many individuals out of hiding in burrows or from under vegetation and debris.

Primarily burrowing species are rarely taken in open water. Nearly all of the collections of these species have been made by simply digging the specimens out with a spade.

Methods of preservation: Specimens from each locality were placed in jars half filled with five percent formalin. All of the collections were subsequently washed with tap water in the laboratory and transferred to seventy-five percent alcohol as a permanent preservative.

Curatorial technique: Collections from a given locality in the field often contained more than one species. Consequently several species might be included under one field number. In the laboratory when the species were identified, each species was catalogued under a lot number. Both the field numbers and the lot numbers ran consecutively.

The early catalogue entries in the University of Kansas Museum of Natural History collection were by lot number. In addition to the lot number, selected specimens representative of the lot were given individual numbers. The individual numbers ran consecutively.

Presently the lot numbers only are used and a record is kept of the number of each sex in the lot. The individual numbers have been discontinued. Aside from convenience in study, the individual numbers were deemed unnecessary.

Specimens examined: Specimens examined during the preparation of this paper included materials from various sources. By far the largest number of specimens are contained in the collection of the University of Kansas Museum of Natural History. Specimens from the University of Oklahoma collection were examined, types and paratypes and other specimens in the United States National Museum and the Museum of Comparative Zoology, Harvard College, were examined, and a large series including paratypes were borrowed from the University of Michigan for study. A few lots from the private collection of Dr. Horton H. Hobbs, Jr., were borrowed for study.

In the species accounts which follow the sources of the specimens examined are indexed by the prefix on the numbers. Specimens from the University of Kansas Museum of Natural History are prefixed by the word "Lot." Specimens from the United States National Museum are prefixed by U.S.N.M., those from the Museum of Comparative Zoology at Harvard College are prefixed by M.C.Z., those from the University of Michigan Museum of Zoology are prefixed by M, and those from the University of Oklahoma collection are prefixed by O.

Additional records: The localities listed under additional records are taken from the literature. These localities are documented by author, date and page in the historical account given above. A limited number of specimens have been examined since the maps were made and are not represented by symbols on the maps. They are designated by U.S.N.M. number under the heading "Additional records."

Synonymy: The synonymies found in the species accounts which follow are intended to be histories of the species. The synonymies include: (1) reference to the original description; (2) references to descriptions of synonyms of the species; (3) references to changes in generic status.

Maps: The shaded areas on the maps which accompany the distributional data for each species represent the distribution of that species within the region as now understood. The solid circles indicate localities from which specimens have been examined. The solid triangles represent additional records for which specimens have not been examined. A few records of specimens examined from the University of Oklahoma collection are represented on the maps but are not documented under the heading "Specimens examined."

Illustrations: The illustrations of most of the diagnostic characters which accompany the species accounts have been made by tracing paper photographic negatives with India ink. The figures are mirror images of the photographed structures. The photographs were then reduced with a potassium ferricyanide solution and fixed in hypo. The annuli of the females were photographed on film, enlarged and traced as above. Pubescence has been shown only on the illustrations of the chelae. The illustrations of the carapaces and chelae of all species are approximately natural size. The gonopods and antennal scales are shown at a magnification of approximately five times natural size and the annuli are shown at a magnification of approximately eight times natural size.

LIFE HISTORY STUDIES OF CRAYFISHES

Many workers have contributed critical notes on parts of the life histories of different species of North American crayfishes, but well integrated works on life histories as such have been few. Andrews (1895, 1904, 1907) made as series of studies on the mating and reproductive phenomena of American crayfishes. Chidester (1912) reported one of the first studies on the biology of the crayfish. Creaser (1933) did work on seasonal changes in the males of

Orconectes propinquus, and Van Deventer (1937) made a study on the biology of this same species. Tack (1941) made a detailed study of the life history and ecology of *Orconectes immunis*, and Penn (1943) studied the life history of *Cambarus clarkii*. Aside from these studies no sustained work on life histories has been reported, and no species occurring in the Ozark-Ouachita Mountains region has been the subject of a critical life history study where it occurs within these provinces.

Data on life histories, especially that of *Orconectes immunis* have been summarized by Williams and Leonard (1952).

TAXONOMIC CHARACTERS OF THE CAMBARINAE

The taxonomic characters which are of most value in the subfamily Cambarinae are the gonopods (first pleopods) of the males, and the annulus ventralis of the females (see glossary). These structures have consistently been used by modern workers, and are thought to be more indicative of the relationships of the various groups than are any other characters. The gonopods and the annulus ventralis apparently are less influenced by environmental factors than are any other external characters exhibited by these crayfishes.

Previously, the hooks on the ischiopodites of the second, third, or fourth pair of pereiopods were thought to be indicative of relationships, but recent workers have shown that relationships based on this character are unreliable. Similar patterns or combinations of hooks on this member of the legs have been developed independently in widely divergent stocks, hence reliance on this character would necessarily consolidate heterogenous assemblages of species. However, the character is useful if its limitations are recognized at the outset.

The shape of the rostrum, presence or absence of lateral rostral spines, length and width of the areola, shape of the chela, shape and size of the antennal scale, and shape of the anterior process of the epistoma are all characters which have usefulness in classifying crayfishes, but all of these characters apparently are subject to environmental influences or individual variations. For example, the rostrum in burrowing types of crayfishes may be greatly depressed and is often reduced in size with the lateral spines reduced or absent. The width of the areola is apparently greater in those species which inhabit well aerated waters, while the width of the areola is apparently less in burrowing species or in species that inhabit waters subject to stagnation. The shape of the chelae in burrowing types is usually compact, either short, inflated and rounded, or slender and elongate, while that of the species inhabiting open waters is more generalized. In general the antennal scale of the burrowing types is usually reduced in size while that of the species inhabiting open water is relatively larger, although exceptions to this generalization occur. *Procambarus simulans,* for example, has a large broad antennal scale, while a closely related species, *Procambarus gracilis* has a small antennal scale. The shape of the anterior process of the epistoma is of some aid in identification of species but in general it is a poor character because it has wide limits of variation.

Characters of lesser value which are of use only on a specific level are the shape of the carapace, the sinuosity of the cephalic groove, the presence or absence of a branchiostegal spine and the presence or absence of a median carina on the rostrum. Color is a poor diagnostic character in most species, but it is an aid to the experienced observer.

DIMORPHISM OF MALES AND DESCRIPTION OF GONOPODS

Male crayfishes of the subfamily Cambarinae exhibit a dimorphism in the shape and texture of the gonopods. Males in a sexually active state are known as form I males. Juvenile males or males in a sexually inactive state are known as form II males. Form II males transform into form I by the process of molting, and form I males may revert to form II by molting. The form I male gonopod is characterized by possession of at least one terminal process which is well defined and corneous. Form II males possess gonopods with poorly defined thickened terminal processes none of which is corneous. The species are defined primarily on the basis of characters exhibited by the form I male.

In the following discussion of previously described species the gonopods of both forms of the males are illustrated, but description of only the form I males is given. The reason for this procedure is simply that the form II males are structurally essentially identical with the form I males. Some differences do exist. The chief differences are: chelae in form II males are lighter and smaller than in form I males; hooks on the ischiopodites of form II males are smaller than in form I males; the thickened, noncorneous gonopods of form II males are characteristic, but not diagnostic of the species, while the well-defined, corneous gonopod tips of form I males are diagnostic of the species.

Since the specific distinctions in crayfishes are based primarily on the shape of the form I male gonopod, a clear understanding of the structure of this organ is absolutely essential. Hobbs (1940, 1942b:25, 1945) has defined the parts of this organ. For purposes of description the gonopod is considered as directed ventrad, thus the surface which is dorsal in normal position is considered the cephalic surface, and the surface which is ventral in normal position is considered the caudal surface.

The gonopod is essentially a thin flat plate which has been rolled about its longitudinal axis to form a tubular structure. Primitively a series of points or processes were developed on the distal edge of this tube. This condition, variously modified, is retained in the genera *Procambarus, Troglocambarus, Paracambarus* and *Cambarellus*, and is greatly modified in the genera *Orconectes* and *Cambarus*. The reader is referred to the glossary for a definition of the processes which occur on the species under consideration in this study. The names of the processes appear in the species accounts.

GLOSSARY OF COMMON TERMS USED IN IDENTIFICATION OF CRAYFISHES

Acumen: tip of rostrum.

Adventitious process: process on caudolateral or lateral border of *Procambarus* gonopods: corneous, thin and bladelike in form I males.

Annulus ventralis: sperm receptacle on sternum of female between posterior two pairs of walking legs.

Antennal scale: lateral bladelike structure at base of antenna.

Areola: usually hourglass-shaped area lying dorsally over midsagittal plane of thorax; bounded by grooves or lines which delimit dorsomesial limits of gill chambers.

Branchiostegite: lateral side of thorax covering gill chamber.

Carina: median dorsal spindle-shaped eminence near tip of rostrum.

Carpus: fifth joint distad on legs.

Caudal process: minute terminal process on caudal border of *Procambarus* gonopod; corneous in form I males.

Central projection: strong projection formed by fusion of centrocephalic and centrocaudal processes; located centrally on tip of *Procambarus* gonopod, laterally on *Orconectes* and *Cambarus* gonopod; corneous in form I males.

Cephalic groove: sinuous, oblique groove separating cephalothorax into an anterior and posterior portion.

Cephalic process: process located cephalomesially on tip of *Procambarus* gonopod.

Chela: pincer or claw; large chelae sometimes called the hands.

Corneous: horny texture.

Epistoma: plate on ventral side of head which bears a roughly triangular cephalic extension.

Gonopod: modified first abdominal swimmeret of male.
Ischius: third joint distad on legs.
Lateral rostral spines: spines lateral to acumen on anterior border of rostrum.
Mesial process: process located caudomesially on *Procambarus* gonopod; mesially on *Orconectes* and *Cambarus* gonopod.
Merus: fourth joint distad on legs.
Obsolescent: underdeveloped, nearly absent.
Pereiopod: Any of the walking or large chelate legs.
Pleurae: overhanging plates on sides of abdominal segments.
Postorbital ridge: ridge on dorsolateral aspect of head, caudolateral to and nearly continuous with sides of rostrum.
Process: any of variously shaped "points" or "teeth" at distal end of gonopods.
Punctations: little pits in exoskeleton.
Rostrum: dorsomedian anterior extension of head partially covering eye stalks and bases of antennae and antennules.
Sinus: cavity or depression in the annulus ventralis.
Spine: any sharp pointed eminence not on gonopods.
Squamous: flat, scalelike.
Sternum: ventral more or less flat plate situated between the walking legs.
Tubercle: a low rounded eminence.

CHECK-LIST OF CRAYFISHES OCCURRING IN THE OZARK AND OUACHITA PROVINCES

- Family Astacidae
  - Subfamily Cambarinae Hobbs 1942
    - Genus *Procambarus* Ortmann 1905
      - Section *barbatus* Hobbs 1942
        - Group *barbatus* Hobbs 1942
          - *Procambarus simulans* (Faxon) 1885
          - *Procambarus gracilis* (Bundy) 1876
      - Section *blandingii* Ortmann 1905
        - Group *blandingii* Ortmann 1905
          - *Procambarus blandingii acutus* (Girard) 1852
          - *Procambarus tenuis* Hobbs 1950
        - Group *spiculifer* Ortmann 1905
          - *Procambarus vioscae* Penn 1946
    - Genus *Orconectes* Cope 1872
      - Section *limosus* Ortmann 1905
        - *Orconectes harrisonii* (Faxon) 1885
      - Section *propinquus* Ortmann 1905
        - Group *hylas* Creaser 1934
          - *Orconectes eupunctus* Williams 1952
          - *Orconectes marchandi* Hobbs 1948
          - *Orconectes quadruncus* (Creaser) 1933
          - *Orconectes peruncus* (Creaser) 1931
          - *Orconectes hylas* (Faxon) 1889
          - *Orconectes nana nana* Williams 1952
          - *Orconectes nana macrus* Williams 1952
          - *Orconectes leptogonopodus* Hobbs 1948

Orconectes punctimanus (Creaser) 1933
Orconectes ozarkae Williams 1952
Orconectes menae (Creaser) 1933
Group *rusticus* Ortmann 1905
Orconectes neglectus neglectus (Faxon) 1885
Orconectes neglectus chaenodactylus Williams 1952
Orconectes luteus (Creaser) 1933
Orconectes medius (Faxon) 1885
Section *virilis* Ortmann 1905
Group *virilis* Ortmann 1931
Orconectes meeki meeki (Faxon) 1898
Orconectes meeki brevis Williams 1952
Orconectes longidigitus (Faxon) 1898
Orconectes nais (Faxon) 1885
Orconectes immunis (Hagen) 1870
Group *palmeri* Ortmann 1931
Orconectes palmeri longimanus (Faxon) 1898
Orconectes difficilis (Faxon) 1898
Genus *Cambarus* Erichson 1846
Section *hamulatus* Ortmann 1905
Cambarus setosus Faxon 1889
Section *extraneus* Ortmann 1905
Cambarus hubbsi Creaser 1931
Section *diogenes* Ortmann 1905
Cambarus diogenes Girard 1852

KEY TO THE GENERA OF CRAYFISHES IN THE OZARK-OUACHITA PROVINCES

1. Gonopods nearly straight, terminating in three or more bladelike or spinous processes . . . . *Procambarus,* p.
1′. Gonopods terminating in two processes 2
2. Gonopods terminating in two elongate, nearly straight or curved processes . . . . *Orconectes* p.
2′. Gonopods terminating in two short processes strongly curved caudad at angle of approximately 90 degrees to axis of shaft . . . *Cambarus,* p.

ACCOUNTS OF SPECIES

Genus *Procambarus* Ortmann

The genus *Procambarus* has been defined by Hobbs (1942a:341) as follows: "First pleopod of first form male terminating in from two to five distinct parts which may be truncate, platelike or spiniform. Shoulders present or absent on cephalic surface of distal third. If the pleopod terminates in only two parts this shoulder is always present. Hooks present on the ischiopodites of the third or of the fourth pereiopods in the male. Third maxillipeds of normal size bearing a row of teeth along the inner margin of the ischiopodite."

Three sections belonging to this genus are found in the Ozark-Ouachita Provinces.

The *barbatus* section: The *barbatus* section as defined by Hobbs (1942b:33) contains two groups only one of which is present in the region. This is the *barbatus* group that has been defined by Hobbs (1942b:35) as follows: "First pleopod of first form male terminates in four distinct parts and bears no decided hump or shoulder on cephalic margin. Areola relatively . . . [long and narrow]; . . . no lateral spines present on rostrum nor are margins interrupted (except occasionally in *[P.] latipleurum*); hooks present on ischiopodites of third, or third and fourth pereiopods."

Two species (*P. simulans* and *P. gracilis*) belonging to this group are found in this region. Both of these species have a wide distribution and may be considered as emigrants into the mountainous provinces from two centers of dispersal. *Procambarus simulans* is a southwestern species which ranges through the southwestern plains region of the United States and has invaded only the western portion of the Ouachita Province. The range of this species will probably be found to extend as a narrow tongue into the Arkansas Valley in Arkansas when more complete collections have been made. This species has been reported from Saline County, Arkansas.

Procambarus gracilis is a species which apparently has its center of distribution in the central or upper Mississippi Valley (Ortmann 1905:104) and from there has emigrated in all directions reaching westward as far as northeastern Kansas, southward in Missouri to the Ozark Plateaus, and southward into Oklahoma along the western border of the Ouachita Province.

The ranges of these two species overlap slightly in Kansas as has been pointed out by Williams and Leonard (1952:978). The ranges also have been found to overlap in Oklahoma. Where the species are in association, only the juveniles are commonly found together.

The *blandingii* section: This section has been defined by Hobbs (1942b:93) as follows: "Cephalodistal margin of first pleopod of male never bears a ridge or knoblike prominence unless it is a part of one of the terminal processes; distad the appendage may be directed straight or caudad; mesial process generally bent (either caudodistad or caudolaterad), a crescentric *[sic]* terminal protuberance never present; cephalic process when present arises from cephalic or cephalolateral margin, never from mesial surface; hooks present on ischiopodites of third and fourth pereiopods."

The *blandingii* section can be divided into three groups of which two occur in the Ozark-Ouachita Provinces.

The *blandingii* group: The *blandingii* group has been defined in part by Hobbs (1942b:93) as follows: ". . . hooks on the ischiopodites of the third and fourth pereiopods; a relatively narrow or obliterated, long areola and a complex of general similarities that are easier to see than to define precisely. Among these is the structure of the rostrum which may or may not bear lateral spines; if lateral spines are absent, then the margins are always interrupted."

Two species belonging to this group (*P. blandingii acutus* and *P. tenuis*) occur in the Ozark-Ouachita Provinces. This group as a whole has a wide distribution in southeastern United States, along the Atlantic seaboard, and in the Mississippi Valley. The center of distribution of the group is probably the Gulf Coastal region (Ortmann, 1905:105), hence those species which occur in the mountainous provinces may be considered as invaders from the south and southeast.

The distribution of *P. b. acutus* clearly demonstrates this contention since the species is found only along the southeastern periphery of the mountainous provinces. *Procambarus tenuis* however shows relatively remote relationships to the rest of the *blandingii* section and apparently is endemic to the Ouachita Province.

The *spiculifer* group: Hobbs (1942b:119) has defined the *spiculifer* group as follows: "The first pleopod of the first form male terminates in three or four parts (the cephalic process is lacking in *[P.] spiculifer*) with no hump along the cephalic margin of the appendage; mesial process spiculiform and always prominent; cephalic process when present relatively small and in apposition with and partially hooding the central projection; central projection conspicuously corneous and making up the bulk of the terminal part of the appendage, although it is relatively slenderer; caudal process arises from the base of and caudolaterad of the central projection and is the least conspicuous of the four terminal processes. . . . Rostrum bears a well developed lateral spine along either margin and terminates in a long acumen; areola wide and much shorter than cephalic section of carapace; hooks present on ischiopodites of third and fourth pereiopods in male."

One species (*Procambarus vioscae*) belonging to this group occurs in the southern portion of the Ouachita Province. The *spiculifer* group like the *blandingii* group apparently had its center of distribution in the southern Appalachians and the Gulf Coastal Plain (Ortmann, 1905:105).

Key to Species in the Genus Procambarus

1. Hooks on ischius of third pereiopods only ...... *barbatus* section, 2
1′. Hooks on ischius of third and fourth pereiopods, *blandingii* section, 3
2. Antennal scale widest posterior to midlength, *Procambarus simulans* (Faxon), p.
2′. Antennal scale widest anterior to midlength, *Procambarus gracilis* (Bundy), p.
3. Carapace with one branchiostegal spine on each side or with none, *blandingii* group, 4
3′. Carapace with two branchiostegal spines on each side, *spiculifer* group, *Procambarus vioscae* Penn, p.
4. Entire rostrum nearly triangular with small lateral rostral spines near apex .... *Procambarus blandingii acutus* (Girard), p.
4′. Entire rostrum not triangular, lateral rostral spines absent, *Procambarus tenuis* Hobbs, p.

Procambarus simulans (Faxon)

Figs. 1-9

Cambarus simulans Faxon, Proc. Amer. Acad. Arts and Sci., Vol. 20, No. 7, 1885, p. 112. (Type locality: Dallas [Dallas County], Texas).
Cambarus gallinus Cockerell and Porter, Proc. Acad. Nat. Sci. Philadelphia, 1900, p. 434.
Cambarus baumgartneri Harris [*nomen nudum*], Trans. Kansas Acad. Sci., Vol. 17, 1901, p. 115.
Procambarus simulans, Hobbs, Amer. Midl. Nat., Vol. 28, No. 2, 1942, p. 342.

Recognition Characters. Male form I: Rostrum (fig. 4) broad at base with convex sides converging abruptly near apex to short acumen, broadly excavated; each postorbital ridge ending in low anterior spine, lateral to but nearly continuous with lateral edges of rostrum; cephalothorax ovate; cephalic groove continuous laterally; branchiostegal spine sharp, poorly developed; sides of areola not parallel, with two or three rows of punctations at narrowest point; antennae shorter than body; antennal scale (fig. 9) unevenly rounded mesially, widest posterior to mid-length, subtruncate anteriorly, apical spine small; chelae (fig. 5) elongate, fingers long, not agape, palm with squamous ciliated tubercles dorsally, mesially and laterally, tubercles most numerous laterally and mesially forming single irregular row along mesial border of palm, fingers tuberculate proximally, punctate distally; carpus with single prominent mesial spine continuous with row of ventral spines, scattered tubercles ventrally; anterior process of epistoma broader than long, lateral sides convex, acute anterior median spine; ischius of third pereiopods each with a strong hook.

Gonopods (figs. 2, 7) straight, truncate, terminating in six processes; a long curved noncorneous mesial process; a shorter non-

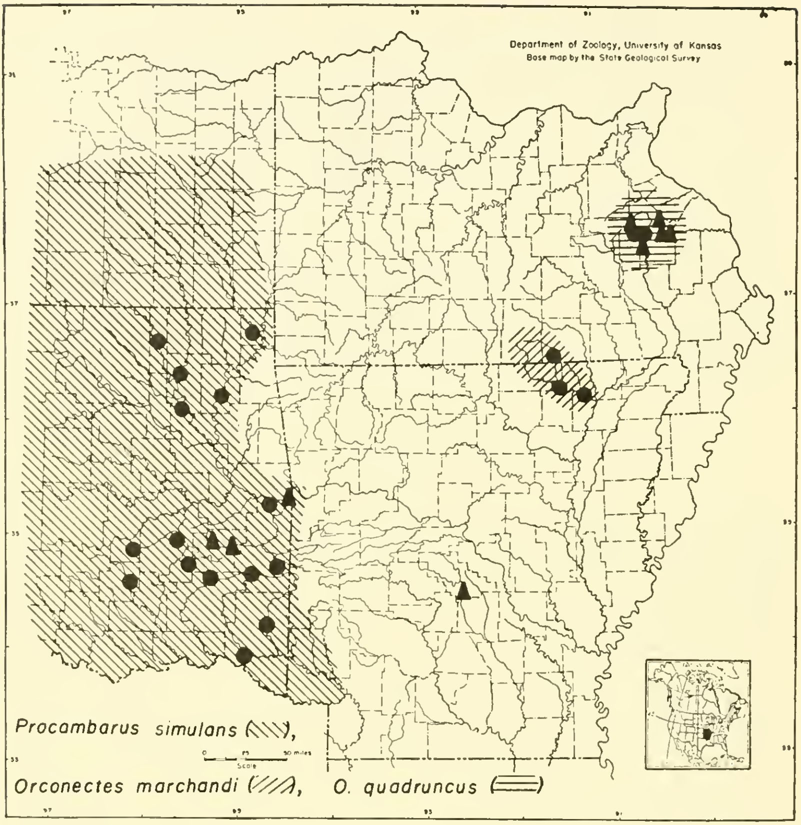

Department of Zoology, University of Kansas
Base map by the State Geological Survey
Procambarus simulans (⧹⧹⧹),
Scale
Orconectes marchandi (///),
O. quadruncus (=)

FIG. 1. Distribution of *Procambarus simulans*, *Orconectes marchandi* and *O. quadruncus* in the Ozark Plateaus and Ouachita Provinces.

corneous cephalic process; a corneous centrocephalic process and a corneous centrocaudal process fused to form a long curved central projection; and a small thick partially cornified bladelike caudal process mesial to a large lateral cornified bladelike adventitious process.

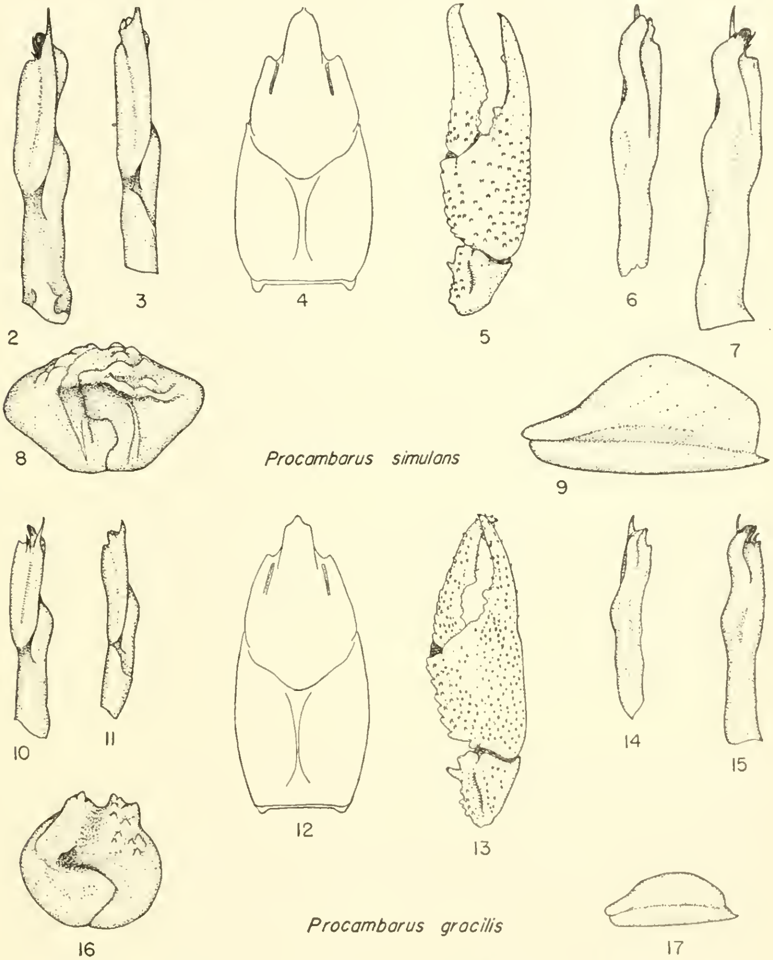
Male form II: (figs. 3, 6).

Female: Sinus in annulus ventralis (fig. 8) with no overhanging borders; anterior margin of annulus more or less toothed; annulus divided by a sinuous fissure.

Variations: The annulus ventralis shows individual variations ranging from an extremely toothed anterior border to a condition in which the anterior border is nearly smooth. Williams and

Leonard (1952:975) report a male form I from Kansas which has an imperfectly developed hook on the ischius of the right second pereiopod.

Ecological Notes: The known observations on the ecology of *Procambarus simulans* have been summarized by Williams and



Procambarus simulans. Lot 196; 3½ mi. W McPherson, McPherson County, Kansas; 26 Apr. 1947. Fig. 2, ♂ I gonopod, mesial view; Fig. 7, ♂ I gonopod, lateral view; Fig. 3, ♂ II gonopod, mesial view; Fig. 6, ♂ II gonopod, lateral view; Fig. 4, Carapace; Fig. 5, Chela and carpus; Fig. 8, Annulus ventralis; Fig. 9, Antennal scale. *Procambarus gracilis.* Lot 767; 1 mi. S Lawrence, Douglas County, Kansas; 20 Apr. 1950. Fig. 10, ♂ I gonopod, mesial view; Fig. 15, ♂ I gonopod, lateral view; Fig. 11, ♂ II gonopod, mesial view; Fig. 14, ♂ II gonopod, lateral view; Fig. 12, Carapace; Fig 13, Chela and carpus; Fig. 16, Annulus ventralis; Fig. 17, Antennal scale.

Leonard (1952:975). *Procambarus simulans* is a primarily burrowing species which often constructs burrows in or at the edge of temporary pools which sometimes are far from permanent surface water. This species occurs infrequently in Kansas streams, but has been reported as inhabiting streams and ponds in Oklahoma. Burrows of *P. simulans* are often topped with chimneys, and the burrows may vary from a few inches to more than three feet in depth.

Females bearing eggs have been observed as early as August and as late as May. Attached young have been observed in late April.

Procambarus simulans is associated with *P. blandingii acutus, P. gracilis, Orconectes nais* and *O. palmeri longimanus* where these species occur within its range.

Specimens Examined: Seventeen from Ozark-Ouachita Provinces as follows: OKLAHOMA. *LeFlore County:* Lot 808. 3 mi. W Whitesboro; Lot 836. Roadside pond at Page; *McCurtain County:* Lot 826. 5½ mi. W Idabel; *Ottawa County:* Lot 821. Ditch, 1½ mi. SW Miami; *Pittsburg County:* Lot 797. A small stream, 2½ mi. SE McAlester; Lot. 801. Roadside ditch, 10-12 mi. S Hartshorne; *Pushmataha County:* Lot 804. Approximately 6 mi. W Sardis; *Wagoner County:* Lot 665. 18 mi. E Tulsa; Types and Paratypes in U.S.N.M. and M.C.Z.

Additional Records: ARKANSAS. *Saline County:* U.S.N.M. 46322. Saline River at Benton; OKLAHOMA. *Latimer County:* 2 mi. W Wilburton; *LeFlore County:* 5½ mi. SW Fort Smith, Arkansas.

Known Range: Arkansas, Colorado, Kansas, New Mexico, Oklahoma and Texas.

Procambarus gracilis (Bundy)

Figs. 10-18

Cambarus gracilis Bundy, Bull. Illinois State Lab. Nat. Hist., 1876, p. 5. (Type locality: Normal, McLean County, Illinois.)
Procambarus gracilis, Hobbs, Amer. Midl. Nat., Vol. 28, No. 2, 1942, p. 342.

Recognition Characters: Male form I: Rostrum (fig. 12) depressed, deeply excavate dorsally, with sides nearly parallel, converging gradually to point near apex where sides converge sharply to form small acumen; postorbital ridges distinct, not terminating in anterior spine or tubercle; cephalothorax subcylindrical, laterally compressed; cephalic groove interrupted laterally; areola narrow, obliterated at middle; antennae shorter than body; antennal scale (fig. 17) evenly rounded mesially, widest anterior to mid-length; chelae (fig. 13) narrow, palm heavily muscled, fingers agape, heavily punctate dorsally, laterally and ventrally, with distinct mesial row of raised tubercles on palm and proximal half of movable finger, one or two obsolescent rows of tubercles on dorsomesial aspect of palm; carpus with single mesial row of spinous tubercles terminating in strong anterior spine, squamous tubercles dorsomesially; anterior process of epistoma triangular with sides curved laterad; ischius of third pereiopods each with a hook.

Gonopods (figs. 10, 15) straight, terminating in six points which consist of: a noncorneous long curved mesial process; a shorter noncorneous cephalic process; a corneous centrocephalic process and a corneous centrocaudal process fused to form a long curved central projection; an extremely small corneous caudal process with an accessory lateral point; an adventitious caudolateral corneous bladelike process bent in a right angle with lateral side in line with sagittal plane of body; and a small caudal process within right angle formed by adventitious process.

Male form II: (figs. 11, 14).

Female: Annulus ventralis (fig. 16) divided by a sinuous fissure with deepest portion to right of midline in anterior half; anterior portion of annulus with deep cleft bordered by raised tuberculate margins. The sculpture of the annulus ventralis is highly variable.

Ecological Notes: Observations on the ecology of *P. gracilis* have been reviewed by Williams and Leonard (1952:981). *Procambarus gracilis* is primarily a burrowing species, but is also found in pools, ditches, ponds and rarely in streams. Adults are sometimes observed at the mouths of their burrows at night or when the surface of the ground is wet. Burrows vary from a few inches to six feet or more in depth.

Females with young attached have been found as early as October, and more abundantly in early spring. Females with eggs attached have not been reported.

Procambarus gracilis is associated with *P. simulans, P. blandingii acutus, Orconectes nais* and *Cambarus diogenes* where these species occur within its range.

Specimens Examined: Seventeen from Ozark-Ouachita Provinces as follows: MISSOURI. *Lawrence County:* Lot 482A. A small creek, 7⁷⁄₁₀ mi. WSW Mt. Vernon. OKLAHOMA. *Muskogee County:* Lot 762. Pond, 6 mi. N Gore; *Pittsburg County:* Lot 798. Pond, 2½ mi. SE McAlester; *Pushmataha County:* Lot. 805. Approximately 6 mi. W Sardis; Cotypes at MCZ.

Additional Records: MISSOURI. *Jasper County:* Day Brook; *Vernon County:* U.S.N.M. 88477. Near town of Milo; OKLAHOMA. *Johnston County:* Connorville.

Known Range: Arkansas, Illinois, Iowa, Kansas, Missouri, Oklahoma, Wisconsin.

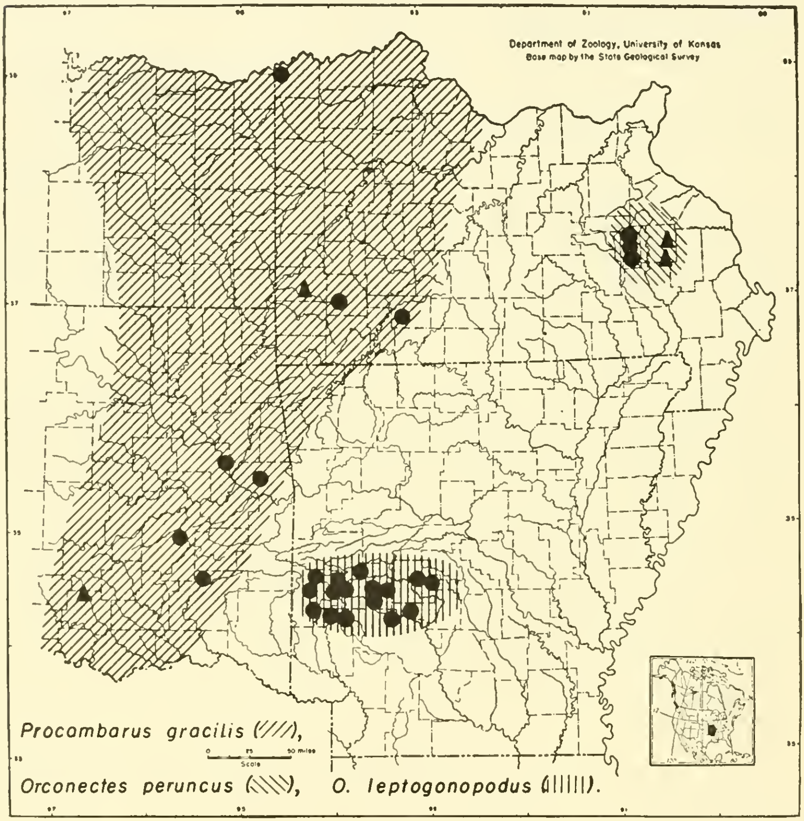

Department of Zoology, University of Kansas
Base map by the State Geological Survey
Procambarus gracilis (////),
Scale
Orconectes peruncus (\\\\),
O. leptogonopodus (||||||).

FIG. 18. Distribution of *Procambarus gracilis, Orconectes peruncus* and *O. leptogonopodus* in the Ozark Plateaus and Ouachita Provinces.

Procambarus blandingii acutus (Girard)

Figs. 19-26; 82

Astacus blandingii Harlan, Trans. Amer. Philos. Soc., new series, Vol. 3, No. 15, 1830, p. 464.
Cambarus acutus Girard, Proc. Acad. Nat. Sci. Philadelphia, Vol. 6, 1852, p. 91. (Type locality: Mobile River, Kemper County, Mississippi.)
Cambarus acutissimus Girard, *Ibid.*, p. 91.
Cambarus stygius Bundy, Bull. Illinois State Lab. Nat. Hist., 1876, p. 3.
Procambarus blandingii acutus, Hobbs, Amer. Midl. Nat., Vol. 28, No. 2, 1942, p. 341, figs. 7-8.

Recognition Characters: Male form I: Rostrum (fig. 21) subtriangular in outline with shallow excavation dorsally, acumen subtriangular, lateral spines greatly reduced; postorbital ridges each terminating anteriorly in a blunt spiniform tubercle; cephalothorax subovate, compressed, conspicuously tuberculate laterally; cephalic groove nearly continuous laterally, lateral spine reduced; areola with sides subparallel, two rows of punctations at narrowest point; antennae shorter than body; antennal scale (fig. 26) unevenly rounded mesially, widest proximal to mid-length, anterior margin truncate mesial to small terminal spine; chelae (fig. 22) slender, elongate, palm with conspicuous squamous tubercles on all surfaces, and with prominent single row of tubercles on mesial border, fingers not agape, movable finger tuberculate proximally; carpus with single well-developed spine and numerous small spines mesially, squamously tuberculate dorsomesially; anterior process of epistoma roughly rhomboid in outline with anterior and lateral spines acute; ischius of third and fourth pairs of pereiopods each with a hook.

Gonopods (figs. 19, 24) more or less straight, terminating in four distinct parts: a noncorneous spinelike mesial process projecting strongly caudolaterad; the other three parts all corneous, bladelike and more or less twisted, consisting of a cephalic process extending mesiocaudad; a central projection composed of two incompletely fused portions extended caudolaterad along caudal border of cephalic process; and a caudal process in apposition with caudolateral edge of central projection extending caudolaterad. (Of the corneous processes the central projection is heaviest and longest.)

Male form II: (figs. 20, 23).

Female: Annulus ventralis (fig. 25) elongate, elliptical in outline; no sinus present, central portion inflated and divided by a shallow sinuous longitudinal fissure; sternal plates with pattern of three tubercles on each side slightly overhanging annulus ventralis, tubercles apparently modified to mesh with projections of gonopods of male during coition.

Color in life: Ground color light yellow, heavily overlaid with greenish-gray mottlings in definite design; dark streaks dorsolaterally reaching from eye to uropods interspaced by a light area and bounded laterally by a light area; hands with greenish-gray maculations dorsally; fingers greenish-gray, tipped with orange; underparts off-white except fingers dark, uropods and telson with dark maculations.

Variations: Individual variation in the length of the lateral rostral spines is common.

Ecological notes: Hobbs and Marchand (1943:20) have summarized the data on the ecology of *Procambarus blandingii acutus.* The species has been reported from woodland swamps, bogs, swiftly flowing streams, creeks, rivers, ditches, and ponds. In the region of Reelfoot Lake, Tennessee, they reported it from streams, ponds and ditches where the bottom is mud or clay. My own observations are meager, but I have found the species in drainage ditches and stagnant warm muddy streams in southeastern Missouri, and in cool springfed streams in central Arkansas.

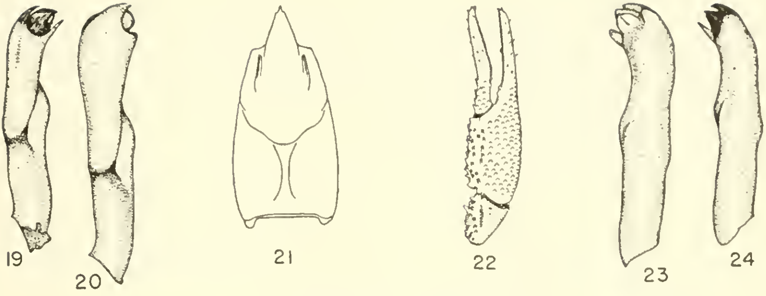
Hobbs and Marchand found form I males in June and July and I have found first form males in August and September.

Procambarus blandingii acutus is associated with *P. gracilis, P. simulans, Orconectes ozarkae, O. nais* and *O. palmeri longimanus* where these species occur within its range.

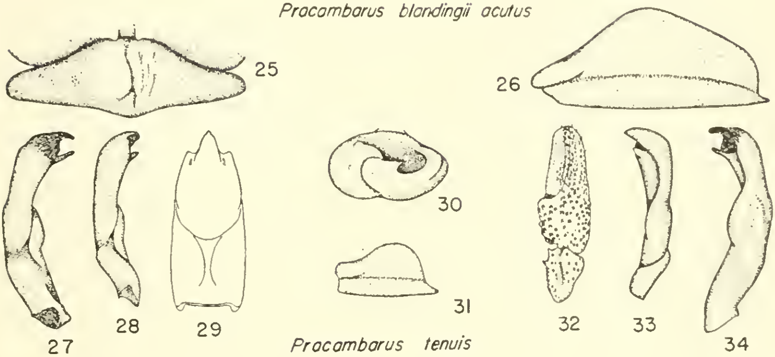
Specimens Examined: Twenty as follows: ARKANSAS. *Garland County:* Lot 570. South Fork River, 5 mi. SE Mountain Valley; *Sharp County:* Lot 605. Hackney Creek, 4⁶⁄₁₀ mi. WSW Stuart. MISSOURI. *Butler County:* Lot 408. Drainage canal, 8 mi. NW Qulin; Lot 410. A small creek, 17 mi. E Doniphan on Mo. hy. no. 14. OKLAHOMA. *Pittsburg County:* Lot 800. Brushy Creek, 8 mi. SW Hartshorne.

Additional records: ARKANSAS. *Dallas County:* U.S.N.M. 89073. 1 mi. N Farringdale; *Greene County:* U.S.N.M. 89069. 10 mi. SE Paragould; *Nevada County:* U.S.N.M. 88508. 2 mi. S Prescott; *Pulaski County:* U.S.N.M. 19762. Little Rock. MISSOURI. St. Louis, Mississippi bottoms. OKLAHOMA. *Choctaw County:* Tributary Kiamichi River, Goodland; *Hughes County:* U.S.N.M. 88507. 2 mi. W Holdenville; North Canadian River, 7 mi. S Weleetka; *Latimer County:* U.S.N.M. 88435. Pond above Fourche Maline Creek, 1 mi. E Wilburton; U.S.N.M. 88453. 2 mi. E Wilburton; Buffalo Creek, 5 mi. NW Tuskahoma; Section House Creek, 5 mi. SW Wilburton; Brazil Creek, 3 mi. N Red Oak; 2 mi. W Wilburton; Pond on college campus at Wilburton; Fourche Maline Creek, 1½ mi. E Wilburton; *LeFlore County:* Arkansas River, 5½ mi. SW Fort Smith; Poteau River, 4 mi. S, 5 mi. W Fort Smith; Wister; 5½ mi. E Fanshawe; *McCurtain County:* Tributary Mountain Fork River, 9 mi. E Broken Bow; *Pittsburg County:* McAlester; *Pushmataha County:* Walnut Creek, 1 mi. SW Albion; *Rogers County:* Verdigris River, 5 mi. W Claremore; *Tulsa County:* Tulsa.

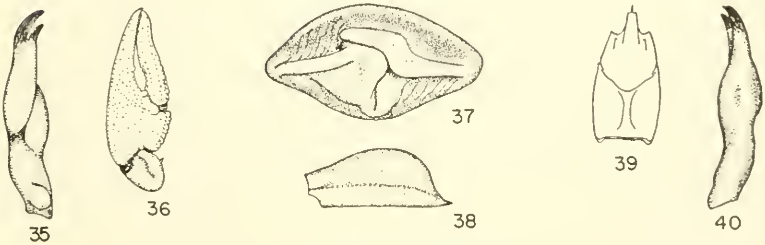
Known range: Alabama, Arkansas, Illinois, Indiana, Iowa, Louisiana, Michigan, Mississippi, Missouri, Ohio, Oklahoma, Tennessee,



Procambarus blandingii acutus



Procambarus tenuis



Orconectes harrisonii

Procambarus blandingii acutus. Lot 410; 17 mi. E Doniphan, Butler County, Missouri; 21 Aug. 1948. Fig. 19, ♂ I gonopod, mesial view; Fig. 24, ♂ I gonopod, lateral view; Fig. 20, ♂ II gonopod, mesial view; Fig. 23, ♂ II gonopod, lateral view; Fig. 21, Carapace; Fig. 22, Chela and carpus; Fig. 26, Antennal scale. Lot 570; 5 mi. SE Mountain Valley, Garland County, Arkansas; 6 Sept. 1948. Fig. 25, Annulus ventralis. *Procambarus tenuis.* Lot 693; 6 mi. NW Langley in Montgomery County, Arkansas; 5 Oct. 1948. Fig. 27, ♂ I gonopod, mesial view; Fig. 34, ♂ I gonopod, lateral view; Fig. 29, Carapace; Fig. 31, Antennal scale; Fig. 32, Chela and carpus. Lot 810; 9½ mi. NW Mena, Polk County, Arkansas; 25 Mar. 1951. Fig. 28, ♂ II gonopod, mesial view; Fig. 33, ♂ II gonopod, lateral view; Fig. 30, Annulus ventralis. *Orconectes harrisonii.* Lot 365; Irondale, Washington County, Missouri; 18 Aug. 1948. Fig. 35, ♂ I gonopod, mesial view; Fig. 40, ♂ I gonopod, lateral view; Fig. 36, Chela and carpus; Fig. 37, Annulus ventralis; Fig. 38, Antennal scale; Fig. 39, Carapace.

Wisconsin. The species has also been reported from Kansas, North Carolina, South Carolina and Vera Cruz, Mexico. The Kansas record has not been confirmed by recent collections from Kansas, and the Carolina and Mexican records have been questioned by Hobbs and Marchand (1943:19).

Procambarus tenuis Hobbs

Figs. 27-34; 41

Procambarus tenuis Hobbs, Jour. Washington Acad. Sci., Vol. 40, No. 6, 1950, p. 194, 12 figs. (Type locality: six miles east Page and just west of Oklahoma State Line, LeFlore County, Oklahoma.)

Recognition Characters: Male form I: Rostrum (fig. 29) subtriangular, broadly excavated dorsally, acumen short, lateral spines absent; postorbital ridges with no anterior spine; cephalothorax subcylindrical, greatly compressed; cephalic groove sinuous, interrupted laterally, lateral spines absent, areola with two rows of punctations at narrowest point; antennal scale (fig. 31) unevenly rounded mesially, widest anterior to mid-length; chelae (fig. 32) with palm inflated, punctate, with flattened ciliated tubercles on all sides, and along lateral margin of immovable finger, fingers heavily ridged dorsally, fingers with opposed margins finely serrate, with larger scattered tubercles inserted along borders of opposed margins; ischius of third and fourth pairs of pereiopods with a hook.

Gonopods (figs. 27, 34) terminating in three distinct points: A noncorneous mesial process projecting caudad at nearly a 90 degree angle with axis of shaft; a prominent corneous central projection terminating lateral portion of gonopod; and a corneous bladelike cephalic process arising from mesiodistal border of mesial portion of gonopod.

Male form II: (figs. 28, 33).

Female: Annulus ventralis (fig. 30) laterally elongate with prominent posterior border, anterior border sunken; annulus divided by sinuous fissure, deepest portion of fossa in anterior half.

Color in life: (Male form I) Dorsally: light olive, lighter on sides, grading to pink at lower part of gill cover, cephalothorax mottled with dark olive spots 1 mm. in diameter, few on abdomen, hand light olive to pink with numerous punctations, fingers olive, ridge on fingers deep olive green, telson and uropods pink-tan. Ventrally: appendages pink, abdomen colorless, telson and uropods pink-tan, gonopods light pink. Female similar to male, annulus pink.

Variations: No variations of consequence have been noted in the specimens examined.

Ecological notes: This species has been collected from under rocks in clear cold streams, where it is apparently quite active even in very cold water.

Procambarus tenuis is associated with *P. vioscae, Orconectes palmeri longimanus,* and perhaps with *O. menae* and *O. leptogonopodus* where these species occur within its range.

Specimens examined: Sixteen as follows: ARKANSAS. *Montgomery County:* Lot. 692. Little Missouri River, Camp Albert Pike Recreation Area, 7 mi. NW Langley; *Polk County:* Lot 810. 9½ mi. NW Mena; OKLAHOMA. *LeFlore County:* Lot 831. 6 mi. E Page and just W of Oklahoma state line; *Pittsburg County:* Lot 803. Creek, 3 mi. NW Counts.

Known range: The known range of this species is confined to the above localities.

Genus *Orconectes* Cope

The genus *Orconectes* has been defined by Hobbs (1942a:350) as follows: "First pleopod of first form male terminating in two distinct parts, both parts ending in straight or gently curved, short or long spines (occasionally the central projection, "outer part", terminates in a bladelike process). Never is a strongly developed shoulder present on the cephalic margin near the tip of the appendage. The central projection is corneous while the mesial process is usually much softer. In the male, hooks are generally present on the ischiopodite of the third pereiopod only, but occasionally they are present on that of the third and fourth pereiopods. Third maxillipeds of normal size with a row of teeth along the inner margin of the ischiopodite."

The genus *Orconectes* contains four sections as recognized by Ortmann (1905:111). Three of these sections (*limosus, propinquus, virilis*) have members which occur in the Ozark-Ouachita Provinces, and all of these sections possess members which are endemic to these provinces. The three sections apparently had their original center of dispersal in central United States in the Mississippi Valley (Ortmann 1905:115). From this center the stock spread centrifugally, but chiefly to the north, east, and west.

The *limosus* section has a discontinuous distribution, with members on the Atlantic Coastal Plain, in the Ohio River Valley and associated drainages, and in the Ozark Plateaus Province.

The *propinquus* section also has a discontinuous distribution; it has dispersed northward and eastward to the Great Lakes and the Appalachian Mountains, but westward this section is confined to the Ozark-Ouachita Provinces with some extension into Kansas and eastern Colorado.

The *virilis* section has a continuous distribution with members which have dispersed in all directions from the center of dispersal, northward into Canada, eastward to the Atlantic Coastal Plain, southward to the Gulf Coastal Plain and westward to the Rocky Mountains.

The *limosus* section: The *limosus* section has been defined by Ortmann (1931:64) as follows: "Gonopods of male short, rather thick up to near the tips, reaching to the coxopodites of the third peraeopod [*sic*]. Tips separated for a short distance only, each tapering to a point. Males with hooks on third, or third and fourth peraeopods [*sic*]."

One species (*O. harrisonii*) belonging to the *limosus* section occurs in the Ozark Plateaus Province. This species is confined to the St. Francois Mountains region in eastern Missouri.

The *propinquus* section: The *propinquus* section can be defined as follows: Gonopods of male reaching to bases of first, second or third pereiopods; terminal elements deeply split; central projection always slender; mesial process usually slender but if thick, with a prominent longitudinal troughlike groove on cephalic surface; hooks on ischius of third or third and fourth pereiopods. Three groups of the *propinquus* section have been recognized of which two (*hylas, rusticus*) occur in the Ozark-Ouachita Provinces.

The *hylas* group: The *hylas* group can be defined as follows: Tips of gonopods reaching to bases of first or second pereiopods; terminal elements of gonopods subequal in length, central projection usually longer; central projection setiform or not setiform; annulus ventralis large, subrhomboid in outline with deep central sinus and with caudal margin projected caudad, or circular with margins raised (*O. menae*), or with surface nearly plane (*O. eupunctus*).

The *hylas* group has undergone great diversification in the Ozark-Ouachita Provinces. Apparently the most primitive members of the group occupy the eastern and southeastern portions of the Ozark Plateaus Province and from there have dispersed northward, westward and southwestward. Four regions of endemism seem to have developed within this group.

The first of these regions is in the St. Francois Mountains in eastern Missouri. This region has been treated by Creaser (1934) who made an attempt to explain the peculiar distribution of endemic species (*O. quadruncus, O. peruncus, O. hylas* in part) in the headwaters of several major streams on the basis of stream piracy.

A second region of endemism lies in the Eleven Point and Spring River drainages in southeastern Missouri and northeastern Arkansas where at least two species (*O. eupunctus* and *O. marchandi*) are common to these two rivers, and are found in no other streams in the Ozarks. These two are the most primitive species in the *hylas* group, and they occur in association in these streams.

A third region of endemism is found in southwestern Missouri, northeastern Oklahoma and northwestern Arkansas where *Orconectes nana nana* and *O. nana macrus* occur. These two subspecies form a unit which is completely isolated from the remainder of the *hylas* group.

A fourth region of endemism is found in the Ouachita Mountains. At least two species of the *hylas* group (*O. leptogonopodus* and *O. menae*) common to this area are found in no other place, and one procambarid (*Procambarus tenuis*) is endemic to this area.

Since the larger portion of the *hylas* group is dispersed through the Ozark Province and only two species of the group are found south of the Arkansas River in the Ouachita Province, and since at least one of these species in the Ouachita Mountains has its closest relatives in the western portion of the Ozark Province, it is reasonable to assume that conditions were at one time favorable for a continuous distribution of the *hylas* group over both the Ozark Plateaus and Ouachita Provinces with the predecessors of at least two species ranging into the Ouachita region. At least two predecessors are postulated because the two species now residing in this region are apparently not closely related.

The *rusticus* group: The *rusticus* group can be defined as follows: Tips of gonopods of form I male reaching to the base of first or second pair of pereiopods; central projection longer than mesial process, corneous, setiform; mesial process noncorneous; hooks on ischius of third pair of pereiopods.

This widely distributed group is found only in the Ozark Plateaus Province of the region under consideration, and is represented by three species, one of which shows subspecific differentiation. *Orconectes medius* alone has a restricted distribution which is confined to the St. Francois Mountains region in eastern Missouri. *Orconectes* *luteus* ranges over much of the Ozark highland and reaches its most westward extension in the Marais des Cygnes River (Osage River of Missouri) in eastern Kansas.

Most outstanding in its peculiar distribution is *Orconectes neglectus neglectus.* This subspecies was described by Faxon (1885: 142) from Wabaunsee County in east central Kansas. As pointed out by Williams and Leonard (1952:987) the subspecies today has a discontinuous distribution. Recent collections show that the main distribution of the subspecies at present is in the four-state area of Arkansas, Kansas, Oklahoma and Missouri, but an isolated population still exists in the Wabaunsee County area in east central Kansas. The subspecies was reported from extreme northwestern Kansas and eastern Colorado by Engle as late as 1926.

The habitat preference of *O. n. neglectus* is apparently for clear rocky streams in relatively undisturbed areas. Such streams occur in the areas now populated by this subspecies. Streams throughout Colorado, Kansas and Missouri were no doubt fairly clear before the prairies were broken by the early settlers. Assuming that this was true, the distribution of *O. n. neglectus* may be presumed to have been continuous within historic times but due to silting of streams following the breaking of the prairies by early settlers, conditions may have become intolerable for the subspecies thus eliminating it in all except relatively undisturbed areas.

The *virilis* section: The *virilis* section has been defined by Ortmann (1931:90) as follows: "Gonopods generally rather long (rarely somewhat shorter), reaching about to the second peraeopods *[sic],* deeply split, tips slender (rarely somewhat stout), and more or less gently *recurved both in the same direction.* Always the third peraeopods *[sic]* only with hooks in the male."

This section is widely distributed over the provinces under consideration, represented by four species which are endemic to the Ozark-Ouachita Provinces and two which are evidently invaders from the north. The section can be further subdivided into two groups which occur in these provinces.

The *virilis* group: The *virilis* group has been defined by Ortmann (1931:90) as follows: "Carapace not compressed; lateral spines present; rostrum mostly without keel; areola not obliterated." *Orconectes longidigitus, O. meeki meeki* and *O. meeki brevis* are endemic to the Ozark Plateaus Province, being found in the White River and its tributaries and in tributaries to the Arkansas River. Two other species (*O. nais, O. immunis*) occur in the Ozark Plateaus Province. Both may be considered as immigrants from the north, but of the two, *O. nais* has been the most successful in penetrating the region.

The *palmeri* group: The *palmeri* group has been defined by Ortmann (1931:90) as follows: "Carapace not compressed; lateral spines present; rostrum without keel; areola obliterated in the middle." One species and one subspecies (*O. difficilis* and *O. palmeri longimanus*) occur in the Ouachita Province. *Orconectes difficilis* is without doubt closely related to the *O. palmeri* complex and represents one of the most westward extensions of the group. *Orconectes palmeri longimanus* is clearly the western form of *O. palmeri palmeri* which occurs in the Mississippi Embayment.

Key to the Sections of the Genus Orconectes

1. Gonopods with terminal processes nearly straight, reaching only to base of third pair of pereiopods with abdomen flexed (*limosus* section) . . . *Orconectes harrisonii*, p. 839
1′. Gonopods with terminal processes straight or curved, reaching to base of first, second or third pair of pereiopods. (If straight, gonopods always reach base of second or first pair of pereiopods), 2
2. Gonopods with terminal processes not curved in same direction, *propinquus* section . . . p. 840
2′. Gonopods with terminal processes curved in same direction . . . 3
3. Gonopods with distinct shoulder at base of central projection on cephalic surface, *propinquus* section . . . p. 840
3′. Gonopods without a distinct shoulder at base of central projection on cephalic surface, *virilis* section . . . p. 890

Key to the Species of the Propinquus Section

1. Annulus ventralis of females with caudal portion projected into a free tonguelike prominence (*hylas* group) . . . 4
1′. Annulus not as above . . . 2
2. Annulus ventralis with raised portion nearly circular (*hylas* group) . . . 4
2′. Annulus ventralis not circular . . . 3
3. Annulus ventralis nearly plane, central sinus almost completely obliterated (*hylas* group) . . . 4
3′. Annulus not as above (*rusticus* group) . . . 13
4. Annulus ventralis nearly plane, central sinus almost completely obliterated . . . *Orconectes eupunctus*, p. 840
4′. Annulus ventralis not plane but with a definite central sinus . . . 5
5. Annulus ventralis with raised portion nearly circular, *Orconectes menae*, p. 863
5′. Annulus ventralis with raised portion not circular . . . 6
6. Gonopods of males with terminal processes of nearly equal length, 7
6′. Gonopods with terminal processes not equal in length, mesial process much shorter . . . 8
7. Gonopods with tips distinctly separated, mesial process with shallow groove on cephalic surface . . . *Orconectes marchandi*, p. 843

7′. Gonopods with tips closely apposed, mesial process with deep groove on cephalic surface and usually with a subapical caudal spur . . . . . . *Orconectes quadruncus*, p. 844

8. Hooks on ischius of third and fourth pereiopods of males, *Orconectes peruncus*, p. 845

8′. Hooks on ischius of third pereiopod only, of males 9

9. Mesial process of gonopods curved caudad, *Orconectes punctimanus*, p. 856

9′. Mesial process of gonopods never curved caudad 10

10. Rostrum wide, broadly excavated dorsally 11

10′. Rostrum narrow, dorsal excavation forming only a broad groove . . 12

11. Branchiostegal spine present . . . . . . *Orconectes ozarkae*, p. 860

11′. Branchiostegal spine absent . . . . . . *Orconectes leptogonopodus*, p. 854

12. Gonopods reaching to base of second pair of pereiopods, *Orconectes nana nana*, p. 849

12′. Gonopods reaching to base of first pair of pereiopods, *Orconectes nana macrus*, p. 851

13. Rostrum broad with sides nearly straight, sometimes converging anteriorly, carina always present 14

13′. Rostrum not as above 15

14. Male form I with fingers thick, gape less than 25 percent of width of palm . . . . . . *Orconectes neglectus neglectus*, p. 866

14′. Male form I with fingers slender or moderately thick, gape more than 25 percent of width of palm, *Orconectes neglectus chaenodactylus*, p. 869

15. Chelae elongate, lightly punctate . . . . . . *Orconectes luteus*, p. 872

15′. Chelae short, thick, heavily punctate . . . . . . *Orconectes medius*, p. 876

Key to the Species of the Virilis Section

1. Areola never obliterated in middle . . . . . . (*virilis* group) 2

1′. Areola obliterated in middle . . . . . . (*palmeri* group) 6

2. Gonopods with both processes curved caudad at less than 90 degree angle with axis of shaft 3

2′. Gonopods with both processes curved cauded at approximately 90 degree angle with axis of shaft . . . . . . *Orconectes immunis*, p. 890

3. Chelae extremely elongate, nearly as long as carapace, *Orconectes longidigitus*, p. 884

3′. Chelae not as above 4

4. Antennal scale evenly rounded mesially, broadest at mid-length, *Orconectes nais*, p. 886

4′. Antennal scale abruptly rounded mesially anterior to mid-length, 5

5. Rostrum with sides concave, acumen long, *Orconectes meeki meeki*, p. 878

5′. Rostrum with sides not concave, often with sides converging anteriorly, acumen short . . . . . . *Orconectes meeki brevis*, p. 881

6. Mesial process of male form I gonopod curved caudad at approximately 90 degree angle with axis of shaft . . . *Orconectes difficilis*, p. 898

6′. Mesial process of male form I gonopod curved caudad at less than 90 degree angle with axis of shaft, *Orconectes palmeri longimanus*, p. 894

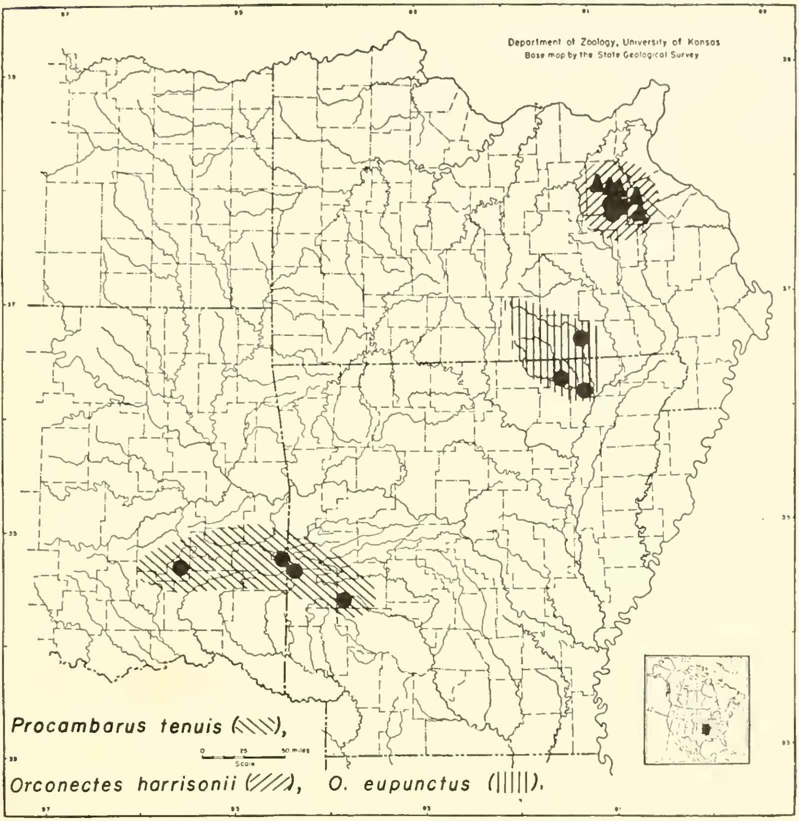

Department of Zoology, University of Kansas
Base map by the State Geological Survey
Procambarus tenuis (\\\\),
0 25 50 miles
Scale
Orconectes harrisonii (////), O. eupunctus (||||).

FIG. 41. Distribution of *Procambarus tenuis*, *Orconectes harrisonii* and *O. eupunctus* in the Ozark Plateaus and Ouachita Provinces.

Orconectes harrisonii (Faxon)

Figs. 35-41

Cambarus harrisonii Faxon, Proc. Amer. Acad. Arts and Sci., Vol. 20, No. 7, 1885, p. 130. (Type locality: Irondale, Washington County, Missouri.)
Orconectes harrisonii, Hobbs, Amer. Midl. Nat., Vol. 28, No. 2, 1942, p. 350.

Recognition characters: Male form I: Rostrum (fig. 39) broad at base with sides converging to small distinct lateral spines, acumen of moderate length; postorbital ridges each terminating anteriorly in a distinct spine; cephalothorax ovate, depressed; cephalic groove interrupted laterally, branchiostegal spine distinct; areola with sides subparallel, three rows of punctuations at narrowest point; antennae longer than body; antennal scale (fig. 38) evenly rounded mesially, widest slightly anterior to mid-length, tip exceeds tip of rostrum;

chelae (fig. 36) broad, punctate, double row of tubercles mesially on palm and proximal third of movable finger; carpus with two or three mesial spines or tubercles, small spine or tubercle near articulation with hand, a conspicuous mesial spine, and usually a small spine or tubercle near articulation with merus; ischius of third pereiopods each with a hook.

Gonopods (figs. 35, 40) terminating in two short processes slightly bent caudad at tips; both processes corneous; lateral process (central projection) longer; tips of processes reaching to base of third pereiopods with abdomen flexed; male form II unknown.

Female: Annulus ventralis (fig. 37) with anterior margin recessed; with median transverse ridge broken at center by sinuous fissure dividing annulus roughly into right and left halves.

Variations: Specimens from Lot 788 (Mine a Breton Creek) tend to have a slightly wider rostrum than those from Lot 365 (Irondale) specimens. Paratypes in the United States National Museum appear to have more heavily punctate chelae than the University of Kansas specimens, but I attribute this to dirt in the punctations which makes them seem deeper than they actually are.

Ecological notes: This species apparently has no peculiar habits, being found beneath rocks and boulders in the streams where it lives.

Orconectes harrisonii is associated with *O. hylas*, *O. punctimanus*, *O. luteus*, *O. medius* and *Cambarus hubbsi* in the parts of its range in which these species occur.

Specimens examined: Eleven as follows: MISSOURI. *Washington County:* Lot 365. Irondale; Lot 370. Cedar Creek, 1½ mi. SE Caledonia; Lot 783. Mine a Breton Creek, 3 mi. SW Potosi; Types at M.C.Z. and paratypes at U.S.N.M.

Additional records: MISSOURI. *St. Genevieve* and *Washington Counties:* Big River and tributaries; *Washington County:* U.S.N.M. 69359. Mine a Breton Creek, 3 mi. S Potosi on highway 21.

Known range: The known range of this species is confined to the above localities.

Orconectes eupunctus Williams

Figs. 41-49

Orconectes eupunctus Williams, Trans. Kansas Acad. Sci., Vol. 55, No. 2, 1952, p. 330, figs. 1-8. (Type locality: Eleven Point River at Riverton, Oregon County, Missouri.)

Recognition characters: Male form I: Rostrum (fig. 44) slightly carinate with sides subparallel, excavate dorsally, deepest near base, acumen subtriangular, tip acute, lateral rostral spines distinct, corneous, subacute; postorbital ridges short, each terminating anteriorly in a strong acute spine; cephalothorax subovate, depressed; cephalic groove nearly continuous laterally, branchiostegal spine small, acute; areola with sides indistinct, subparallel, with four rows of punctations at narrowest point; antennae shorter than body; antennal scale (fig. 46) evenly rounded mesially, widest anterior to mid-length, terminating in prominent anterior spine; chelae (fig. 47) punctate, palm moderately inflated, irregular double row of squamous ciliated tubercles on mesial surface of palm and proximal half of movable finger, fingers agape; carpus with conspicuous broad longitudinal groove dorsally, with single sharp spine and an anterior and posterior tubercle mesially; ischius of third pereiopods each with a strong hook.

Gonopods (figs. 42, 49) terminating in two short nearly straight processes; lateral process (central projection) shorter, corneous, thin; mesial process noncorneous, slightly recurved caudad at tip, dilated near tip, with longitudinal troughlike groove on cephalic surface; tips of processes reach base of second pereiopods with abdomen flexed.

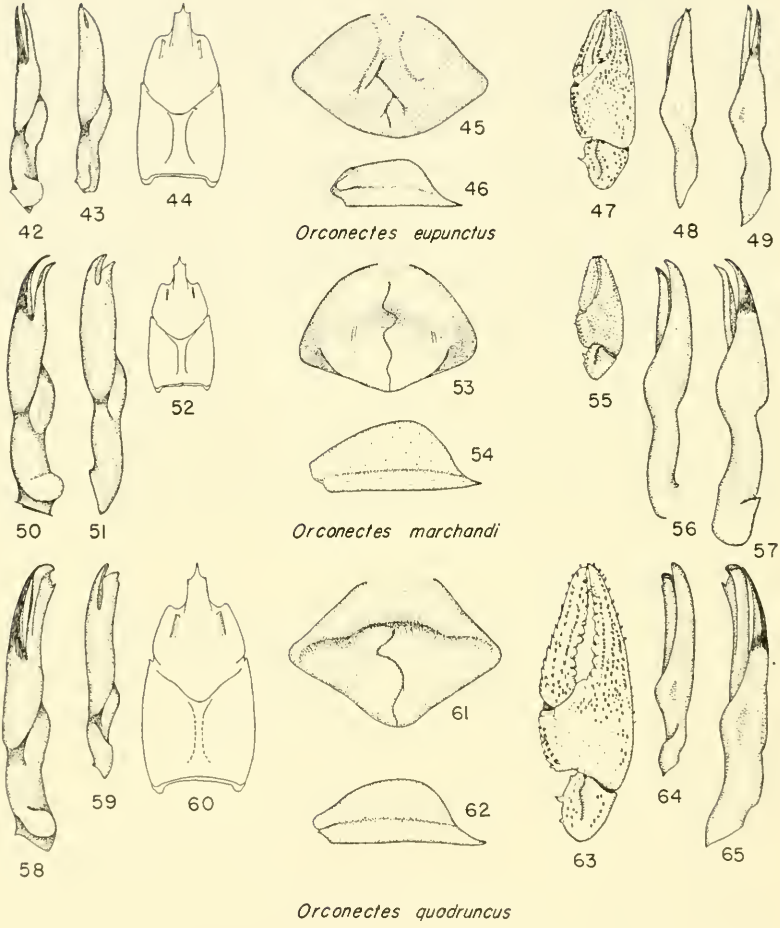
Male form II: (figs. 43, 48).

Female: Annulus ventralis (fig. 45) subelliptical, firmly fused to sternal plate, margins somewhat flattened, cephalic portion with broad shallow median longitudinal trough flanked on each side by a rounded eminence, central and caudal portion divided by a zigzag longitudinal fissure originating in greatly reduced central sinus, fissure curving first sinistrad.

Color in life: Ground color fuscus, almost red on tergae dorsally and laterally, black mottlings on rostrum, postorbital ridges, rear of cephalic region near areola, and a narrow black saddle across rear border of cephalothorax and first abdominal segment; hands olive green dorsally, fingers tipped with orange; tubercles and spines at articulations orange; cephalic border of annulus ventralis light green to greenish-blue; ventral color off-white. General color varies from rust-red to pink to light green in different localities.

Variations: This species is represented by a relatively small series of specimens from only three localities. No marked variations are exhibited by individuals in these lots. The most evident minor variation is the degree of development of the carina on the rostrum which is either absent or weakly present.

Ecological notes: Orconectes eupunctus lives under rocks and in gravel in clear, cold, rapidly flowing streams. It is associated with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Orconectes eupunctus
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Orconectes marchandi
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Orconectes quodruncus

Orconectes eupunctus. Lot 425; Eleven Point River, Riverton, Oregon County, Missouri; 22 Aug. 1948. Fig. 42, ♂ I gonopod, mesial view; Fig. 49, ♂ I gonopod, lateral view; Fig. 43, ♂ II gonopod, mesial view; Fig. 48, ♂ II gonopod, lateral view; Fig. 44, Carapace; Fig. 45, Annulus ventralis; Fig. 46, Antennal scale; Fig. 47, Chela and carpus. *Orconectes marchandi.* Lot 427; 1 mi. NE Thayer, Oregon County, Missouri; 22 Aug. 1948. Fig. 50, ♂ I gonopod, mesial view; Fig. 57, ♂ I gonopod, lateral view; Fig. 51, ♂ II gonopod, mesial view; Fig. 56, ♂ II gonopod, lateral view; Fig. 52, Carapace; Fig. 53, Annulus ventralis; Fig. 54, Antennal scale; Fig. 55, Chela and carpus. *Orconectes quadruncus.* Lot 375; $2\frac{3}{10}$ mi. E Arcadia, Iron County, Missouri; 19 Aug. 1948. Fig. 58, ♂ I gonopod, mesial view; Fig. 65, ♂ I gonopod, lateral view; Fig. 59, ♂ II gonopod, mesial view; Fig. 64, ♂ II gonopod, lateral view; Fig. 60, Carapace; Fig. 61, Annulus ventralis; Fig. 62, Antennal scale; Fig. 63, Chela and carpus.

O. marchandi, O. punctimanus, O. ozarkae, O. nais and *Cambarus hubbsi* where these species occur within its range.

Specimens examined: Seventy-two as follows: ARKANSAS. *Lawrence County*; Lot 593. Spring River, ½ mi. SSE Ravenden; *Sharp County:* Lot 601. Spring River at Hardy; MISSOURI. *Oregon County:* Lot 425. Eleven Point River at Riverton.

Known range: The known range of this species is confined to the above localities.

Orconectes marchandi Hobbs

Figs. 1; 50-57

Orconectes marchandi Hobbs, Amer. Midl. Nat., Vol. 39, No. 1, 1948, p. 139, figs. 1-4, 10-14. (Type locality: small stream 3⁷⁄₁₀ mi. SE Hardy, Sharp County, Arkansas.)

Recognition characters: Male form I: Rostrum (fig. 52) of moderate length, with sides nearly parallel, acumen of moderate length, lateral spines well developed; postorbital ridges each terminating anteriorly in well developed spines; cephalothorax subovate, depressed; cephalic groove interrupted laterally, branchiostegal spine prominent; areola with sides nearly parallel, three rows of punctations at narrowest point; antennal scale (fig. 54) evenly rounded mesially, widest anterior to mid-length; chelae (fig. 55) with setiferous punctations on all surfaces; carpus with distinct mesial spine and anterior and posterior mesial tubercles; anterior process of epistoma subtriangular with anterior surfaces sinuate; ischius of third pereiopods each with a hook.

Gonopods (figs. 50, 57) terminating in two elongate processes; tips of processes curved caudad at angle of approximately 45 degrees with axis of shaft; lateral process (central projection) corneous; mesial process noncorneous with troughlike longitudinal groove on cephalic surface; tips of gonopods reaching base of second pereiopods with abdomen flexed.

Male form II: (figs. 51, 56).

Female: Annulus ventralis (fig. 53) with central fossa; anterior margins inflated; posterior half projected caudad into a prominent tonguelike projection; annulus divided by a sinuous median longitudinal fissure.

Variations: The small collection examined does not exhibit any significant variations.

Ecological Notes: This species is found under rocks and rubble on shoals in running water in the streams where it lives. *Orconectes* *marchandi* is associated with *O. eupunctus, O. punctimanus, O. ozarkae, O. nais* and *Cambarus hubbsi* where these species occur within its range.

Specimens examined: Eleven as follows: ARKANSAS. *Lawrence County:* Lot 587, Spring River, 4 mi. NW Imboden; *Sharp County:* Lot 598, Sugar Creek, 6⁷⁄₁₀ mi. NW Williford; MISSOURI. *Oregon County:* Lot 427, Warm Fork, 1 mi. NE Thayer; Types at U.S.N.M.

Additional Records: ARKANSAS. *Sharp County:* Stream 3⁷⁄₁₀ mi. SE Hardy on U. S. Hy. no. 63.

Known Range: The known range of this species is confined to the localities listed above.

Orconectes quadruncus (Creaser)

Figs. 1; 58-65

Faxonius quadruncus Creaser, Occ. Pap. Mus. Zool., Univ. Michigan, No. 275, 1933, p. 10, figs. 11-12. (Type locality: Stou's Creek, tributary of St. Francis River near Ironton and Arcadia, Iron County, Missouri.)

Orconectes quadruncus, Hobbs, Amer. Midl. Nat., Vol. 28, No. 2, 1942, p. 350.

Recognition characters: Male form I: Rostrum (fig. 60) with margins subparallel, divergent at base, converging anteriorly to reduced blunt lateral spines, acumen long slender; postorbital ridges each terminating anteriorly in a low sharp spine; cephalothorax ovate; cephalic groove nearly continuous laterally, lateral spine distinct; areola poorly defined, with three or four rows of punctations at narrowest point; antennae shorter than body; antennal scale (fig. 62) evenly rounded mesially, widest near mid-length; chelae (fig. 63) moderately heavy, punctate on all surfaces with deep setiferous punctations on fingers and lateral aspect of palm, fingers ridged; carpus with long mesial spine and an anterior and posterior tubercle mesially; anterior process of epistoma rhomboid in outline with apex notched; ischius of third and fourth pereiopods with hooks.

Gonopods (figs. 58, 65) terminating in two processes of nearly equal length; lateral process (central projection) shorter, slender, corneous, curved gently caudad throughout distal half of length; mesial process noncorneous, with longitudinal troughlike groove on cephalic surface and median keel on caudal surface with spur near distal end, process expanded distally.

Male form II: (figs. 59, 64).

Female: Annulus ventralis (fig. 61) rhomboid in outline; caudal two thirds of annulus divided by a sinuous longitudinal fissure, sinus laterally elongate completely traversing width of cephalic portion, deepest point within cephalic half.

Variations: Variations observed are individual and slight.

Ecological Notes: Orconectes quadruncus lives under rocks in the streams where it occurs.

Orconectes quadruncus is associated with *O. luteus* and perhaps with *O. peruncus, O. punctimanus* and *Cambarus hubbsi* where these species occur within its range.

Specimens Examined: Twenty-six as follows: MISSOURI. *Iron County:* Lot 372. Stouts Creek at Ironton; Lot 375. Stouts Creek, 2$^{4}/_{10}$ mi. E Arcadia; M53326 Stouts Creek tributary to St. Francis River, between Ironton and Arcadia: *Madison* County: M53327. Little St. Francis River, 9 mi. E Ironton; Paratypes at U.S.N.M.

Additional Records: MISSOURI. *Iron, Madison* and *St. Genevieve Counties* in the headwaters of the St. Francis River.

Known Range: The known range of this species is confined to the above localities.

Orconectes peruncus (Creaser)

Figs. 18; 66-73

Cambarus peruncus Creaser, Occ. Pap. Mus. Zool., Univ. Michigan, No. 224, 1931, p. 7, figs. 13-17. (Type locality; Little Creek, tributary to St. Francis River, 1 mi. NE Chloride, Iron County, Missouri.)
Orconectes peruncus, Hobbs, Amer. Midl. Nat., Vol. 28, No. 2, 1942, p. 350.

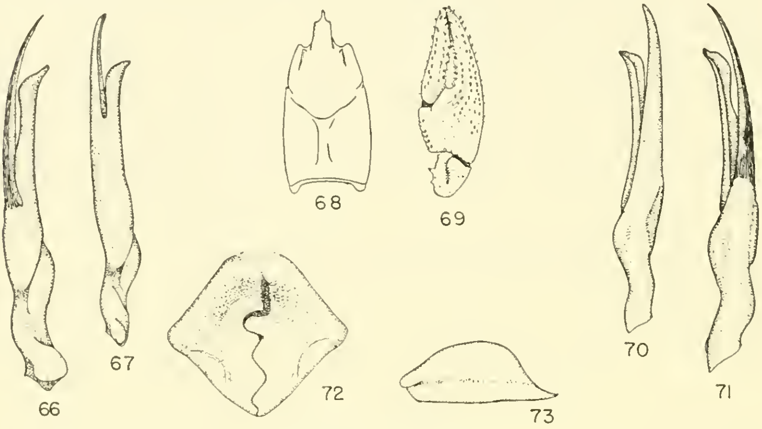
Recognition characters: Male form I: Rostrum (fig. 68) with margins subparallel, converging to blunt lateral spines, margins divergent at base, acumen nearly triangular; postorbital ridges each terminating in a sharp anterior spine; cephalothorax ovate; cephalic groove interrupted laterally, branchiostegal spine small, acute; areola with margins indefinite, four rows of punctations at narrowest point; antennae shorter than body; antennal scale (fig. 73) evenly rounded mesially, widest at mid-length; chelae (fig. 69) conspicuously setose with moderately deep setiferous punctations on fingers; carpus with single mesial spine and with anterior and posterior mesial tubercles; anterior process of epistoma rhomboid in outline; ischius of third and fourth pairs of pereiopods with hooks.

Gonopods (figs. 66, 71) terminating in two elongate processes; lateral process (central projection) longer, corneous, curving gently caudad throughout length; mesial process noncorneous, with longitudinal troughlike groove on cephalic surface, margins of groove sinuate.

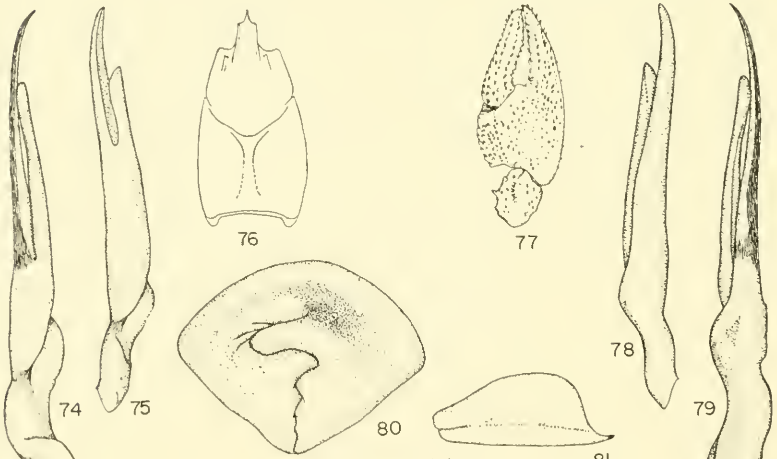
Male form II: (figs. 67, 70).

Female: Annulus ventralis (fig. 72) rhomboid in outline. Cephalic margin partially depressed, caudal margin forming tonguelike projection; annulus divided longitudinally by a sinuous fissure terminating a large deep sinus in cephalic half of annulus.

Color in Life: Ground color reddish-tan, dark olive mottlings on posterior portion and sides of cephalothorax, two large dark macu-



Orconectes peruncus



Orconectes hylos

Orconectes peruncus. Lot 383; Chloride, Iron County, Missouri; 19 Aug. 1948. Fig. 66, ♂ I gonopod, mesial view; Fig. 71, ♂ I gonopod, lateral view; Fig. 67, ♂ II gonopod, mesial view; Fig. 70, ♂ II gonopod, lateral view; Fig. 68, Carapace; Fig. 69, Chela and carpus; Fig. 72, Annulus ventralis; Fig. 73, Antennal scale. *Orconectes hylas.* Lot 389; ½ mi. NW Centerville, Reynolds County, Missouri; 19 Aug. 1948. Fig. 74, ♂ I gonopod, mesial view; Fig. 79, ♂ I gonopod, lateral view; Fig. 75, ♂ II gonopod, mesial view; Fig. 78, ♂ II gonopod, lateral view; Fig. 76, Carapace; Fig. 77, Chela and carpus; Fig. 80, Annulus ventralis; Fig. 81, Antennal scale.

lations anterior to areola on cephalic portion of body; olive bands on carpus and on merus distally; entire body and chelipeds with small olive maculations.

Variations: Slight variations are manifest in shape of acumen, malformed chelae and sculpture of the annulus ventralis.

Ecological notes: Orconectes peruncus is found under rocks and in shallow burrows in the gravel in streams. The species is alert, a rapid swimmer, and is well camouflaged by its coloration.

Orconectes peruncus is associated with *O. punctimanus, O. luteus, Cambarus hubbsi,* and perhaps with *Orconectes quadruncus* where these species occur within its range.

Specimens examined: Fifty-seven as follows: MISSOURI. *Iron County:* Lot 381. Tributary of Big Creek, 3⁹⁄₁₀ mi. NE Hogan; Lot 383. Tributary of Big Creek at Chloride; M53270 Little Creek, tributary of St. Francis River, 1 mi. NE Chloride; M53271. Ruble Spring Branch, 1 mi. S Chloride; Paratypes at U.S.N.M. and M.C.Z.

Additional Records: Iron and *Madison Counties* in the headwaters of the St. Francis River.

Known Range: The known range of this species is confined to the above localities.

Orconectes hylas (Faxon)

Figs. 74-82

Cambarus hylas Faxon, Proc. U. S. Nat. Mus., Vol. 12, 1889, p. 632. (Type locality: West Fork of Black River, Reynolds County, Missouri.)
Orconectes hylas, Hobbs, Amer. Midl. Nat., Vol. 28, No. 2, 1942, p. 350.

Recognition characters: Male form I: Rostrum (fig. 76) with sides subparallel, divergent at base, lateral spines blunt, acumen of moderate length; postorbital ridges each terminating anteriorly in a blunt spine; cephalothorax ovate, cephalic groove interrupted laterally, branchiostegal spine small, acute; areola margins indistinct, with three rows of punctations at narrowest point; antennae shorter than body, antennal scale (fig. 81) evenly rounded mesially, widest anterior to mid-length; chelae (fig. 77) broad, heavy, heavily punctate dorsally, punctations conspicuously ciliated, mesial border of palm and movable finger with single row of conspicuous tubercles; carpus with one conspicuous mesial spine and anterior and posterior tubercle; anterior process of epistoma subtriangular, notched at apex, ischius of third pereiopods with hooks.

Gonopods (figs. 74, 79) terminating in two elongate processes; lateral process (central projection) corneous, considerably longer than mesial process, slightly curved caudad distally with distinct shoulder on cephalic surface near base; mesial process noncorneous, with longitudinal troughlike groove on cephalic surface, deepest distally, tips of central projection reach base of first pereiopods with abdomen flexed.

Male form II: (figs. 75, 78).

Female: Annulus ventralis (fig. 80) rhomboid in outline, cephalic margin recessed, caudal margin elevated, projected caudad, annulus divided by a sinuous fissure curving strongly to right or left of midsagittal plane in anterior half of annulus, deepest portion in cephalic half.

Color in life: Incomplete data on color permits description only as a species which has a brownish ground color, maculate dorsally.

Variations: Some form I males from Lot 392 (Reynolds County) possess hooks on the ischius of the third and fourth pereiopods. Other minor variations are evidenced in rostrum width, length and curvature of the processes on the gonopods, and in sculpture of the annulus ventralis.

Ecological notes: This species is found in burrows under rocks in streams. Specimens have been collected from pools which had the bottom covered with a layer of silt. As many as five form I males have been collected from under a single rock. One collection of five males and females was taken from under a rock only 10 inches in diameter. Both *Orconectes hylas* and *O. punctimanus* have been collected from under the same rocks. In these and other cases the crayfishes were apparently occupying a shallow communal excavation under the rocks.

Orconectes hylas is associated with *O. harrisonii, O. punctimanus, O. luteus, O. medius* and *Cambarus hubbsi* where these species occur within its range.

Specimens examined: One hundred sixty-two as follows: MISSOURI. *Reynolds County:* Lot 386. East Fork of Black River, 1½ mi. E Lesterville; Lot 387. Middle Fork of Black River, 4 mi. NW Lesterville; Lot 389. West Fork of Black River, ½ mi. NW Centerville; Lot 392. Sinking Creek $10\frac{4}{10}$ mi. N Ellington; Lot 393. Logan Creek, ¾ mi. NE Ellington; *Washington County:* Lot 361. Big River, $8\frac{6}{10}$ mi. S Potosi; Lot 367. Cedar Creek, 2 mi. SW Irondale; Lot 371. Cedar Creek, 1½ mi. SE Caledonia; Lot 784. Irondale. Types at M.C.Z.; Paratypes at U.S.N.M.

Additional records: Reynolds County in the headwaters of the Black River; *Iron County:* U.S.N.M. 69358. Keeling Creek on highway 32; *Iron, St. Genevieve* and *Washington Counties* in the headwaters of the Big River.

Known range: The known range of this species is confined to the above localities.

Orconectes nana nana Williams

Figs. 82-90

Orconectes nana nana Williams, Trans. Kansas Acad. Sci. Vol. 55, No. 2, 1952, p. 333, figs. 9-16. (Type locality: Flint Creek, 5 mi. E Kansas, Delaware County, Oklahoma.)

Recognition characters: Male form I: Rostrum (fig. 85) narrow, with sides subparallel, divergent at base, dorsal excavation a deep longitudinal groove, acumen triangular, terminal spine blunt, corneous, lateral rostral spines blunt; postorbital ridges each terminating anteriorly in a stout subacute spine; cephalothorax ovate, depressed, cephalic groove interrupted laterally, branchiostegal spine absent; areola with sides subparallel, five rows of punctations at narrowest point; antennae shorter than body; antennal scale (fig. 87) evenly rounded mesially, broadest near anterior edge, terminal spine long, curved mesiad at tip; chelae (fig. 88) heavy, inflated, fingers agape, punctate, mesial edge of palm with irregular double row of ciliated squamous tubercles, opposed edges of fingers with single row of large flattened tubercles; carpus with shallow sinuous groove and ciliated punctations dorsally, with low stout spine and a low anterior and posterior tubercle mesially and an obsolescent spine ventrally; anterior process of epistoma subrhomboid in outline, apex rounded; ischius of third pair of pereiopods each with a strong hook.

Gonopods (figs. 83, 90) terminating in two elongate processes; a lateral process (central projection) longer, corneous, attenuate distally, slightly curved caudad distally, with low rounded shoulder on cephalic aspect at base; mesial process noncorneous, flared near tip, with shallow longitudinal groove cephalolaterally, small spur on caudomesial edge distally; tips of gonopods reach base of second pair of pereiopods with abdomen flexed.

Male form II: (figs. 84, 89).

Female: Annulus ventralis (fig. 86) subrhomboid in outline, firmly fused to sternum, margin inflated, caudal margin wrinkled; cephalic margin separated by a narrow longitudinal groove, central sinus large, sinus and caudal margin divided by a sinuous fissure curving first sinistrad.

Color in life: Ground color yellow, heavily speckled, with a dark border at posterior edge of cephalothorax.

Variations: The most evident variations in this subspecies lie in the development of the rostral spines, variation in the relative length of the mesial process of the male form I gonopod, presence or absence of the caudomesial spur on the mesial process of the male form I gonopod, and in the sculpture of the annulus ventralis of the female.

Ecological notes: This subspecies is one of the so-called "rock crawlers." This type of crayfish is found under rocks on shoals and at the edge of streams in swift water. The species is almost never found in open water.

Orconectes nana nana is associated with *O. neglectus neglectus, O. meeki brevis* and perhaps with *O. nais* where these species occur within its range.

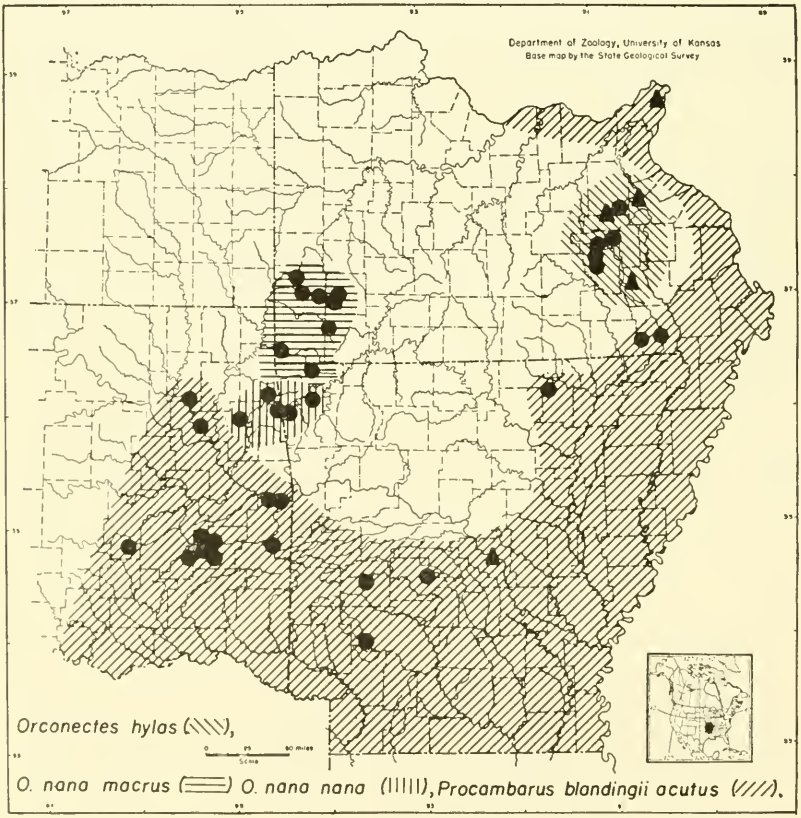

Department of Zoology, University of Kansas
Base map by the State Geological Survey
Orconectes hylos (\\\\),
O. nana macrus (═) O. nana nana (|||||), Procambarus blandingii acutus (////).
Scale
0 25 50 miles

FIG. 82. Distribution of *Orconectes hylas, O. nana nana, O. n. macrus* and *Procambarus blandingii acutus* in the Ozark Plateaus and Ouachita Provinces.

Specimens examined: One hundred thirteen as follows: ARKANSAS. *Washington County:* Lot 527. Clear Creek, 3 mi. SSW Springdale; Lot 666. Illinois River, 19 mi. SE Siloam Springs; OKLAHOMA. *Adair County:* Lot 818. Illinois River, approximately 4 mi. N Westville; *Cherokee County:* Lot 768. 8 mi. N Tallequah; *Delaware County:* Lot 664. Flint Creek, 5 mi. E Kansas.

Known Range: The known range of this subspecies is confined to the above localities.

Orconectes nana macrus Williams

Figs. 82; 91-98

Orconectes nana macrus Williams, Trans. Kansas Acad. Sci., Vol. 55, No. 2, 1952, p. 337, figs. 17-24. (Type locality: Spring River, 2 mi. SW Mt. Vernon, Lawrence County, Missouri.)

Recognition characters: Male form I: Rostrum (fig. 93) narrow, with sides subparallel, divergent at base, dorsal excavation a deep longitudinal groove, acumen triangular, terminal spine blunt, corneous, lateral rostral spines blunt; postorbital ridges each terminating anteriorly in a stout subacute spine; cephalothorax ovate, depressed, cephalic groove interrupted laterally, branchiostegal spine absent; areola with four rows of punctations at narrowest point; antennae shorter than body; antennal scale (fig. 95) evenly rounded mesially, widest near mid-length, terminal spine long, curved mesiad at tip; chelae (fig. 96) heavy, inflated, fingers agape, punctate, mesial edge of palm with irregular double row of ciliated squamous tubercles, opposed edges of fingers with single row of large flattened tubercles; carpus with shallow sinuous groove and ciliated punctations dorsally, with low stout spine and a low anterior and posterior tubercle mesially and a thick blunt obsolescent spine ventrally; anterior process of epistoma rhomboid in outline, apex subacute; ischius of third pair of pereiopods each with a strong hook.

Gonopods (figs. 91, 98) terminating in two elongate slender processes; lateral process (central projection) longer, corneous, attenuate distally, curved gently caudad in distal half of length, with distinct shoulder on cephalic aspect at base; mesial process noncorneous, with shallow longitudinal groove on cephalic border, with tip twisted mesiad, tips of processes reach base of first pair of periopods with abdomen flexed.

Male form II: (figs. 92, 97.)

Female: Annulus ventralis (fig. 94) subelliptical in outline, firmly fused to sternum, sinus large, centrally located in cephalic half, caudal margins wrinkled with median portion projected into a raised tonguelike projection, sinus and caudal portion divided by a sinuous median longitudinal fissure curving first sinistrad.

Color in life: Ground color light tan overlaid with light olive prominent as dorsal band on rear of cephalothorax and first abdominal segment, apex of merus, carpus, mesial margin of palm, rostrum, and thinly spread on cephalothorax dorsally; cheek dirty yellow below eye; body and appendages muddy-tan ventrally.

Variations: Orconectes nana macrus shows the usual minor variations in spination on the carpus and merus of the first pereiopod, slight differences in the shape of the antennal scale and differences in the relative length of the mesial process of the form I male gonopod and in the sculpture of the annulus ventralis of the female.

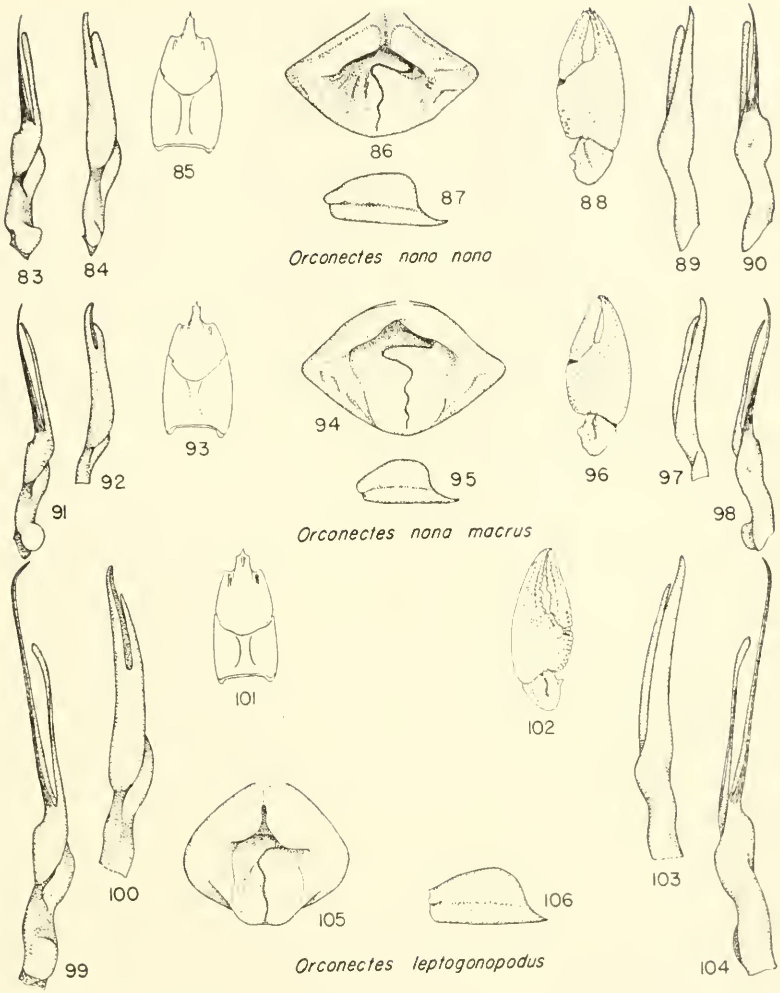
Ecological notes: This subspecies has been found under rocks, in burrows under rocks, and burrows (in sand or mud) which were up to six inches in depth. The individuals apparently prefer to live under well seated rocks overlying sand, small pebbles or mud. *Orconectes n. nana* and *O. n. macrus* show habitat preferences which closely parallel the habits of *Cambarus hubbsi.*

No intergrades between the subspecies *Orconectes nana nana* and *O. nana macrus* have been collected, but because the two forms are morphologically so similar and because the ranges of the two forms are adjacent in the same drainage system they have been judged to be subspecifically distinct. These forms stand in unique relationship to other members of the hylas group. The two subspecies apparently are isolated in their geographic range from all other members of the *hylas* group and form the most northwesterly extension of this group.

Orconectes nana macrus is associated with *O. neglectus neglectus, O. meeki brevis* and perhaps with *O. nais* where these species occur within its range.

Specimens examined: Forty-one as follows: Arkansas. *Benton County:* Lot 523. A small creek, 4½ mi. W Bentonville; Missouri. *Barry County:* Lot 659. Shoal Creek, $2\frac{1}{10}$ mi. E Wheaton; *Jasper County:* Lot 483A. Center Creek, ½ mi. NE Sarcoxie; Lot 486A. Jenkins Creek, $7\frac{7}{10}$ mi. W Sarcoxie; Lot 489A. Spring River, ¼ mi. N Carthage; *Lawrence County:* Lot 494. Truitt Creek, 2 mi. N Mt. Vernon; Lot 497. Spring River, 2 mi. SW Mt. Vernon; *McDonald County:* Lot 517. Patterson Creek, $3\frac{6}{10}$ mi. SSE Tiff City.

Known range: The known range of this subspecies is confined to the above localities.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Orconectes nona macrus
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Orconectes leptogonopodus

Orconectes nana nana. Lot 664; 5 mi. E Kansas, Delaware County, Oklahoma; 26 Sept. 1948. Fig. 83, ♂ I gonopod, mesial view; Fig. 90, ♂ I gonopod, lateral view; Fig. 84, ♂ II gonopod, mesial view; Fig. 89, ♂ II gonopod, lateral view; Fig. 85, Carapace; Fig. 86, Annulus ventralis; Fig. 87, Antennal scale; Fig. 88, Chela and carpus. *Orconectes n. macrus.* Lot 497; 2 mi. SW Mt. Vernon, Lawrence County, Missouri; 27 Aug. 1948. Fig. 91, ♂ I gonopod, mesial view; Fig. 98, ♂ I gonopod, lateral view; Fig. 92, ♂ II gonopod, mesial view; Fig. 97, ♂ II gonopod, lateral view; Fig. 93, Carapace; Fig. 94, Annulus ventralis; Fig. 95, Antennal scale; Fig. 96, Chela and carpus. *Orconectes leptogonopodus.* Lot 683; 5 mi. NW Hartley, Polk County, Arkansas; 3 Oct. 1948. Fig. 99, ♂ I gonopod, mesial view; Fig. 104, ♂ I gonopod, lateral view; Fig. 101, Carapace; Fig. 102, Chela and carpus; Fig. 105, Annulus ventralis; Fig. 106, Antennal scale. Lot 695; Norman, Montgomery County, Arkansas; 5 Oct. 1948. Fig. 100, ♂ II gonopod, mesial view; Fig. 103, ♂ II gonopod, lateral view.

Orconectes leptogonopodus Hobbs

Figs. 18; 99-106

Orconectes leptogonopodus Hobbs, Amer. Midl. Nat., Vol. 39, No. 1, 1948, p. 139, figs. 24-32. (Type locality: McKinneys Creek, $4\frac{7}{10}$ mi. NE Hatfield, Polk County, Arkansas.)

Recognition characters: Male form I: Rostrum (fig. 101) with sides subparallel, divergent at base, acumen short, triangular, lateral rostral spines poorly developed; postorbital ridges each terminating anteriorly in moderately heavy spines; cephalothorax subovate, depressed; cephalic groove interrupted laterally, branchiostegal spines absent; areola with sides not parallel, with three to five rows of punctations at narrowest point; antennae shorter than body; antennal scale (fig. 106) evenly rounded mesially, broadest anterior to mid-length, anterior spine exceeds tip of rostrum; chelae (fig. 102) with fingers grooved and heavily punctate dorsally and ventrally, double row of tubercles mesially on palm and proximal one third of movable finger; carpus with long sharp spine and posterior tubercle mesially; ischius of third pair of pereiopods each with a hook.

Gonopods (figs. 99, 104) extremely long and slender; lateral process (central projection) corneous, longer, thin, bladelike, with tip curved caudad at angle of approximately 45 degrees with axis of shaft; prominent shoulder at base on cephalic border; mesial process approximately one-third shorter than central projection, noncorneous, spatulate at tip, tips of gonopods reaching base of first pair of pereiopods.

Male form II: (figs. 100, 103).

Female: Annulus ventralis (fig. 105) subrhomboid in outline; caudal border extended caudad in tonguelike projection, anterolateral margins inflated, extended centromesiad; annulus divided longitudinally by a sinuous fissure.

Color in life: (Male form I) Ground color slate gray (characteristic of young specimens, older individuals lighter), hands slate gray dorsally; uropods and telson fuscus; dorsolateral paired bright red spots on tergal segments three, four and five; red bar across tergal segment six; light tinge of red at base of telson; pinkish streaks on cheeks and on lower edge of gill cover; body off-white to light pink ventrally; underside of hands off-white to brownish-orange on fingers. (Female) Coloration similar to male; annulus ventralis with anterior inflated areas "old ivory"; lateral and posterior border with slight bluish tinge, blue tint not uniform.

A juvenile specimen in Lot 553 (Polk County) was colored bright orange-red dorsally, only the compound eyes were dark. Other similar individuals were seen but not collected. All of these red individuals were small and were extremely rapid swimmers in fast water on shoals in the stream. Some other specimens in this lot had a reddish tinge as if they had recently exuviated. The stream at this locality flows over shale outcrops and cobbles.

Variations: This species shows minor variations in rostral width. A carina is present on the rostrum of many individuals. Sculpture of the annulus varies widely.

Ecological notes: Orconectes leptogonopodus lives under rocks in streams. The species is usually found in rapidly flowing water on or near shoals.

Orconectes leptogonopodus is associated with *O. menae*, *O. palmeri longimanus* and perhaps with *Procambarus tenuis* and *P. vioscae* where these species occur within its range.

Specimens examined: Three hundred twenty-three as follows: ARKANSAS. *Clark County:* Lot 697. Caddo River, 2½ mi. NE Amity; *Garland County:* Lot 566. Three Forks Walnut Creek, $2\frac{4}{10}$ mi. W Crystal Springs; Lot 568. Glazypeau Creek, 5 mi. SW Mountain Valley; Lot 571. South Fork River, 5 mi. SE Mountain Valley; Lot 573. South Fork River, $8\frac{3}{10}$ mi. NE Hot Springs; *Hot Springs County:* Lot 699. Tributary of Caddo River, 6 mi. W Lambert; Lot 700. A creek 8 mi. E Bismarck; *Howard County:* Lot 688. Saline River, 3 mi. NW Athens; *Montgomery County:* Lot 556. Kates Creek, 2½ mi. SSW Pine Ridge; Lot 559. Ouachita River, 6 mi. NW Mount Ida; Lot 561. South Fork of Ouachita River at Mount Ida; Lot 562. Williams Creek, 3½ mi. SE Mount Ida; Lot 563. Twin Creek, $10\frac{1}{10}$ mi. ESE Mount Ida; Lot 564. A small creek, 1 mi. SE Joplin; Lot 692. Little Missouri River, Camp Albert Pike Recreation Area, 6 mi. NW Langley; Lot 695. Caddo River at Norman; Lot 696. A brook, Crystal Springs Recreation Area, 4 mi. NE Norman; *Pike County:* Lot 690. Little Missouri River, 4 mi. W Langley; *Polk County:* Lot 544. Ouachita River, ½ mi. E Acorn; Lot 547. Tributary of Ouachita River at Mena; Lot 549. Irons Fork, $5\frac{7}{10}$ mi. E Mena; Lot 552. Tributary of Ouachita River, $4\frac{6}{10}$ mi. E Ink; Lot 553. Tributary of Ouachita River, 2 mi. SSE Cherry Hill; Lot 680. Small brook, 4 mi. SSW Mena; Lot 683. Gillam Springs on Cossatat River, approximately 5 mi. NW Hartley; Lot 684. Tributary of Cossatat River, 1½ mi. E Hartley; Lot 686. Twin Springs, SE Slope Whiskey Peak, 3 mi. WSW Hatton; Types in U.S.N.M., and Paratypes in M.C.Z.

Additional records: ARKANSAS. *Polk County:* McKinneys Creek, 4$\frac{7}{10}$ mi. NE Hatfield on U. S. Hy. No. 71.

Known range: The known range of this species is confined to localities listed above.

Orconectes punctimanus (Creaser)

Figs. 107-114; 200

Faxonius punctimanus Creaser, Occ. Pap. Mus. Zool., Univ. Michigan, No. 275, 1933, p. 1, figs. 5-6. (Type locality: Roubidoux Creek, Waynesville, Pulaski County, Missouri.)
Orconectes punctimanus, Hobbs, Amer. Midl. Nat., Vol. 28, No. 2, 1942, p. 350.

Recognition characters: Male form I: Rostrum (fig. 109) broad, deeply excavated dorsally, margins subparallel, slightly divergent at base, converging to thick acute lateral spines, acumen of moderate length, strongly curved dorsad; postorbital ridges each terminating anteriorly in a thick short spine; cephalothorax ovate; cephalic groove interrupted laterally, branchiostegal spines distinct; areola with four rows of punctations at narrowest point; antennae shorter than body; antennal scale (fig. 114) evenly rounded mesially, widest at mid-length; chelae (fig. 110) with setiferous punctations on all surfaces, fingers ridged, with double row of tubercles on mesial surface of palm and proximal half of movable finger and pigmented spot on palm at base of movable finger (usually present even on preserved specimens); carpus with strong mesial spine and anterior and posterior tubercles mesially, low ciliated tubercles on dorsomesial surface; epistoma triangular, notched at tip; ischius of third pair of pereiopods each with a hook.

Gonopods (figs. 107, 112) terminating in two elongate processes; both processes curved gently caudad; lateral process (central projection) long, corneous, curved caudad through distal two thirds of length, with distinct shoulder at base on cephalic surface; mesial process noncorneous, acicular distally, with shallow longitudinal troughlike groove on cephalic surface.

Male form II: (figs. 108, 111).

Female: Annulus ventralis (fig. 113) rhomboid in outline, margins inflated, caudal half elevated, projected caudad, cephalic margins overhanging deep cephalically placed sinus; annulus divided longitudinally by a sinuous fissure curving into sinus.

Color in life: Ground color olive-green (intensity of color varies in different parts of the range); gill cover with slight reddish cast dorsally, faint yellow ventrolaterally; black saddle over cephalothorax caudally continuous with black band along ventrolateral edge of gill cover; paired irregularly shaped maculations on posterior portion of cephalic region; chelae with conspicuous dark spot on dorsal and ventral surfaces near base of movable finger; posterior margins of tergae, uropods and telson brick-red. The degree of maculation varies.

Variations: The rostrum is subject to great variation in width. This is true even in a topotypic lot. The rostrum may be broad with parallel margins or narrow with margins converging anteriorly. The annulus of females in Lots 379 and 382 (Iron County, Missouri) is not rhomboid, but tends to be oval or circular in outline. Lots from the Black River in Reynolds County contain females which show both circular and rhomboid outlines, but there is a predominance of the rhomboid type. Specimens in these lots have extremely wide rostra. Specimens in Lots 435 and 438 (Douglas County, Missouri) have rostra which approach the width of those in the Black River drainage.

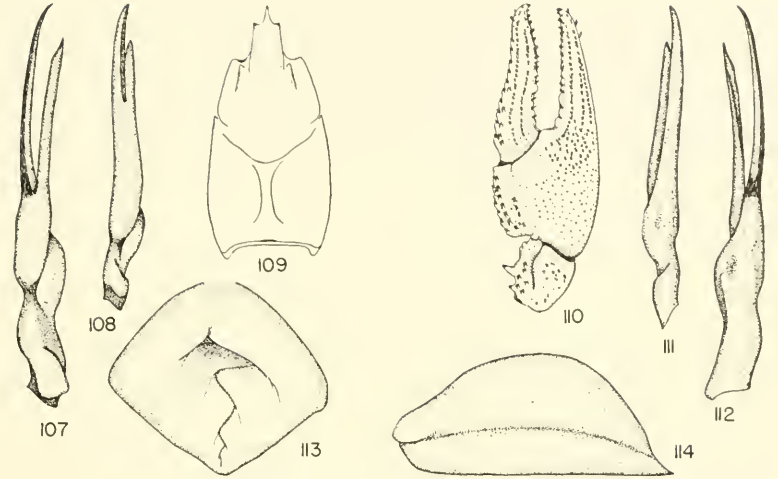
Ecological notes: Orconectes punctimanus adults apparently prefer the muddier portions of streams, being found most abundantly in quiet back water pools, where they hide in vegetation, among the roots of trees in undercut stream banks, or under rocks in deep clay or mud bottomed pools. Small specimens have been obtained under rocks in shallow water near and on shoals.

Orconectes punctimanus is wary, secretive, and extremely active if disturbed. The species is much more active than *O. luteus,* for example. Large *O. punctimanus* have been observed trying to avoid being captured in a seine by violent actions, while *O. luteus* of comparable size placidly rode the net. *Orconectes punctimanus* is much harder to capture by hand than is *O. luteus.* The former is sometimes vicious when aroused and cornered.

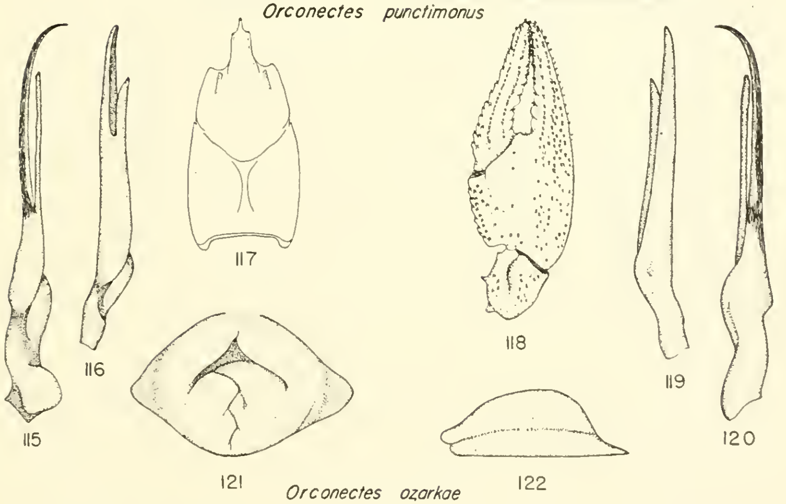
Orconectes punctimanus is associated with *O. harrisonii, O. eupunctus, O. marchandi, O. peruncus, O. hylas, O. ozarkae, O. neglectus chaenodactylus, O. luteus, O. medius, O. longidigitus, O. nais, Cambarus hubbsi,* and perhaps with *Orconectes quadruncus* where these species occur within its range.

Specimens examined: Approximately six hundred seventy-three as follows: Arkansas. *Fulton County:* Lot 603, Worthington Creek, 3⅒ mi. WSW Stuart; M53294. Spring River at mouth of stream, 1 mi. S Mammoth Spring; *Izard County:* Lot 608. Strawberry River, 2½ mi. W Myron; Lot 611. A small creek, 1³⁄₁₀ mi. N Melbourne; *Lawrence County:* Lot 586. Tributary of Spring River, 3⁴⁄₁₀ mi. NNW Powhatan; Lot 589. A small creek, 4⁴⁄₁₀ mi. WNW

Imboden; Lot 592. Spring River, ½ mi. SSE Ravenden; *Sharp County:* Lot 596. Martin Creek, 2 9/10 mi. NE Williford; Lot 599. Sugar Creek, 6½ mi. NW Williford; Lot 600. Spring River at Hardy; Lot 607. Hackney Creek 4 6/10 mi. WSW Stuart. MISSOURI. *Carter County:* Lot 396. Current River at Van Buren; Lot 397. Onyx Cavern, 2 mi. SW Van Buren; M53290. Pikes Creek, 6 mi. W Van Buren; M53292. "Long Bay" 2½ mi. S Big Spring State Park; M53293. Current River at mouth of Pikes Creek, 1 mi. NW Van Buren; M53296. Stream in "Club Hollow" at Big Spring State Park; *Crawford County:* Lot 351. Huzzah Creek, 8 mi. E Steelville; Lot 353. Courtois Creek, 16 mi. E Steelville; Lot 782. Meramec River, 12 mi. W Steelville; *Dent County:* M53285. Stream at Salem; *Douglas County:* Lot 431. Spring Creek, 19 7/10 mi. WNW West Plains; Lot 433. North Fork of White River, 20 mi. WNW West Plains; Lot 435. Brush Creek, 25 mi. SE Ava; Lot 438. Fox Creek, 22 3/10 mi. SE Ava; Lot 440. Bryant Creek, 14 8/10 mi. SE Ava; lot 441. Whites Creek, 8 6/10 mi. SE Ava; *Iron County:* Lot 374. Stouts Creek at Ironton; Lot 378. Stouts Creek, 2 3/10 mi. E Arcadia; Lot 379. Tributary of Big Creek, 3 3/10 mi. NE Hogan; Lot 382. Tributary of Big Creek at Chloride; M53295. Ruble Spring Branch, 1 mi. S Chloride; *Oregon County:* Lot 424. Eleven Point River at Riverton; Lot 426. Eleven Point River at Riverton; Lot 428. Warm Fork, 1 mi. NE Thayer; *Ozark County:* Lot 710. North Fork of White River at Tecumseh; *Phelps County:* Lot 344. Gasconade River, ¼ mi. N Jerome; Lot 346. Little Beaver Creek, 4½ mi. W. Rolla; Lot 349. Dry Fork Creek, 3 mi. SE St. James; *Pulaski County:* Lot 340. Roubidoux Creek, ¼ mi. SE confluence with Gasconade River; Lot 342. Big Piney River, 8 mi. NE Waynesville; *Reynolds County:* Lot 386. East Fork of Black River, 1½ mi. E. Lesterville; Lot 388. Middle Fork of Black River, 4 mi. NW Lesterville; Lot 390. West Fork of Black River, ½ mi. NW Centerville; Lot 391. Sinking Creek, 10 1/10 mi. N Ellington; Lot 394. Logan Creek, ¼ mi. NE Ellington; *Ripley County:* Lot 398. Sinking Creek, 16 mi. S Van Buren; Lot 399. Gooseneck Campsite on Current River, 11 mi. NW Doniphan; Lot 401. Buffalo Creek, ¼ mi. E Bennett; Lot 414. Current River at Doniphan; Lot 419. A small creek 9 mi. W Doniphan; *Shannon County:* M53289. Rocky Creek, 9 mi. NE Winona; M53282. Rocky Creek, 12 mi. NE Winona; *Texas County:* M53288. Potters Creek, 3 mi. NE Cabool; M53291. Big Piney Creek at Cabool; M53281. Big Piney Creek, 6 mi. S Houston; M53284. North Fork of the White River, SW of Cabool; *Washington County:* Lot 356. Fourche a Renault, at Shirley; Lot 358. Mine a Breton Creek, 3 mi. SW



Orconectes punctimonus



Orconectes ozarkae

Orconectes punctimanus. Lot 340; Roubidoux Creek near Gasconade River, Pulaski County, Missouri; 17 Aug. 1948. Fig. 107, ♂ I gonopod, mesial view; Fig. 112, ♂ I gonopod, lateral view; Fig. 108, ♂ II gonopod, mesial view; Fig. 111, ♂ II gonopod, lateral view; Fig. 109, Carapace; Fig. 110, Chela and carpus; Fig. 113, Annulus ventralis; Fig. 114, Antennal scale. *Orconectes ozarkae.* Lot 606; $4\frac{9}{10}$ mi. WSW Stuart, Sharp County, Arkansas; 10 Sept. 1948. Fig. 115, ♂ I gonopod, mesial view; Fig. 120, ♂ I gonopod, lateral view; Fig. 116, ♂ II gonopod, mesial view; Fig. 119, ♂ II gonopod, lateral view; Fig. 117, Carapace; Fig. 118, Chela and carpus; Fig. 121, Annulus ventralis; Fig. 122, Antennal scale.

Potosi; Lot 362. Big River, 8⁶⁄₁₀ mi. S Potosi; Lot 364. Irondale; Lot 366. Cedar Creek, 2 mi. SW Irondale; *Wayne County:* M53283. McKenzie Creek at Piedmont; M53297. Clarks Creek, 11 mi. E Piedmont; M53298. St. Francis River, 12 mi. E Piedmont; *Wright County:* M53300. Gasconade River, 6 mi. N Mansfield; M53286. Stream 20 mi. S Lebanon; M53287. Stream 16 mi. S Lebanon; Paratypes at the U.S.N.M.

Known range: The known range of this species is confined to the above localities.

Orconectes ozarkae Williams

Figs. 115-123

Orconectes ozarkae Williams, Trans. Kansas Acad. Sci., Vol. 55, No. 2, 1952, p. 339, figs. 25-32. (Type locality: Hackney Creek, 4⁶⁄₁₀ mi. WSW Stuart, Sharp County, Arkansas.)

Recognition characters: Male form I: Rostrum (fig. 117) with sides subparallel, slightly sinuous, divergent at base, excavate dorsally, deepest near base, acumen subtriangular, tip acute, lateral spines distinct, somewhat blunted; postorbital ridges short, each terminating anteriorly in a stout acute spine; cephalothorax subovate, depressed; cephalic groove nearly continuous laterally, branchiostegal spine small, acute; areola asymmetrical with sides subparallel, with three rows of punctations at narrowest point; antennae shorter than body; antennal scale (fig. 122) evenly rounded mesially, widest anterior to mid-length; chelae (fig. 118) broad, punctate, palm moderately inflated, fingers agape, palm with double row of raised ciliated tubercles mesially and scattered ciliated tubercles mesiodorsally, movable finger with double row of ciliated tubercles mesially; carpus with conspicuous broad longitudinal groove and scattered setiferous punctations dorsally, with scattered ciliated tubercles mesiodorsally, with a strong mesial spine, an anterior mesial spiniform tubercle, a mesioventral tubercle, and a prominent spine ventrally; anterior process of epistoma subrhomboid in outline, apex truncate; ischius of third pair of pereiopods each with a strong hook.

Gonopods (figs. 115, 120) terminating in two elongate, thin, bladelike processes; lateral process (central projection) longer, corneous, curved caudad at angle of approximately 45 degrees with axis of shaft at tip, with poorly developed shoulder on cephalic surface at base; mesial process noncorneous, straight, with longitudinal troughlike groove on cephalolateral surface; length of mesial process approximately 70 percent of length of central projection; tips of lateral processes reach base of first pereiopods with abdomen flexed.

Male form II: (figs. 116, 119.)

Female: Annulus ventralis (fig. 121) elliptical in outline, fused to sternum, margins inflated, with roughly triangular shaped sinus in cephalic half overhung by cephalic margins, caudal half protuberant, annulus divided by a six segmented zigzag longitudinal fissure originating cephalolaterally and curving first dextrad.

Color in life: Ground color fuscus, cephalothorax with indefinite olive mottlings dorsally, dirty yellow ventrolaterally; hands maculate with black dorsally, fingers tinged with olive; tips of fingers, knob at base of movable finger, postorbital ridges and annulus ventralis orange; posterior border of tergae reddish-brown; body off-white ventrally.

Variations: This species shows marked variations in the processes of the male form I gonopods. These consist of variation in the degree of curvature at the tip of the central projection, in the relative length of the mesial process and in the relative development of the troughlike groove on the cephalolateral aspect of the mesial process. Other slight variations occur in the rostrum shape, width of areola, tuberculation of the mesial margin of the movable finger of the chela and in sculpture of the annulus ventralis.

Ecological notes: This species has been found living under rocks in streams, in burrows under rocks and has been collected from moist burrows under deeply seated rocks in dry stream beds.

Orconectes ozarkae is associated with *O. punctimanus, O. longidigitus, O. nais, Cambarus hubbsi,* and perhaps with *Orconectes neglectus chaenodactylus* where these species occur within its range.

Specimens examined: Two hundred eighty-seven as follows: ARKANSAS. *Boone County:* Lot 647. Crooked Creek, 3⅒ mi. S Harrison; Lot 651. Long Creek, ¾ mi. ESE Alpena Pass; Lot 721. Bear Creek, 1 mi. N Lowry; *Fulton County:* Lot 604. Worthington Creek, 3⅒ mi. WSW Stuart; *Izard County:* Lot 609. Strawberry River, 2½ mi. W Myron; *Lawrence County:* Lot 588. Spring River, 4 mi. NW Imboden; Lots 590 and 591. Spring River, ½ mi. SSE Ravenden; *Sharp County:* Lot 606. Hackney Creek, 4⁶⁄₁₀ mi. WSW Stuart; Lot 709. Big Creek, ½ mi. S Ash Flat; Lot 795. Spring River at Hardy; *Stone County:* Lots 613 and 614. A small creek, 4 mi. E Mountain View. MISSOURI. *Butler County:* Lot 412. Little Black River, 13⁸⁄₁₀ mi. SW Poplar Bluff; *Christian County:* Lot 453. Swan Creek, ½ mi. S Keltner; Lot 456. Finley Creek, at Ozark; *Douglas*

County: Lot 444. A small creek, 3 mi. NW Ava; Lot 447. A small creek, 6 mi. NW Ava; Lot 449. Little Beaver Creek, 3½ mi. W Goodhope; *Greene County:* Lot 460. James River, 1 mi. S Galloway; *Oregon County:* Lot 422. Eleven Point River at Riverton; M53299. Barren Fork near Thomasville; *Ozark County:* Lot 714. Little North Fork Creek at Theodosia; *Ripley County:* Lot 403. Buffalo Creek, ¼ mi. E Bennett; Lot 413. Cypress Creek, 7⁸⁄₁₀ mi. NE Doniphan; Lot 417. Current River at Doniphan; Lot 418. Briar Creek, 2⁹⁄₁₀ mi. NW Doniphan; Lot 420. A small creek, 9 mi. W Doniphan; *Taney County:* Lot 715. Bear Creek, ½ mi. NW Walnut Shade.

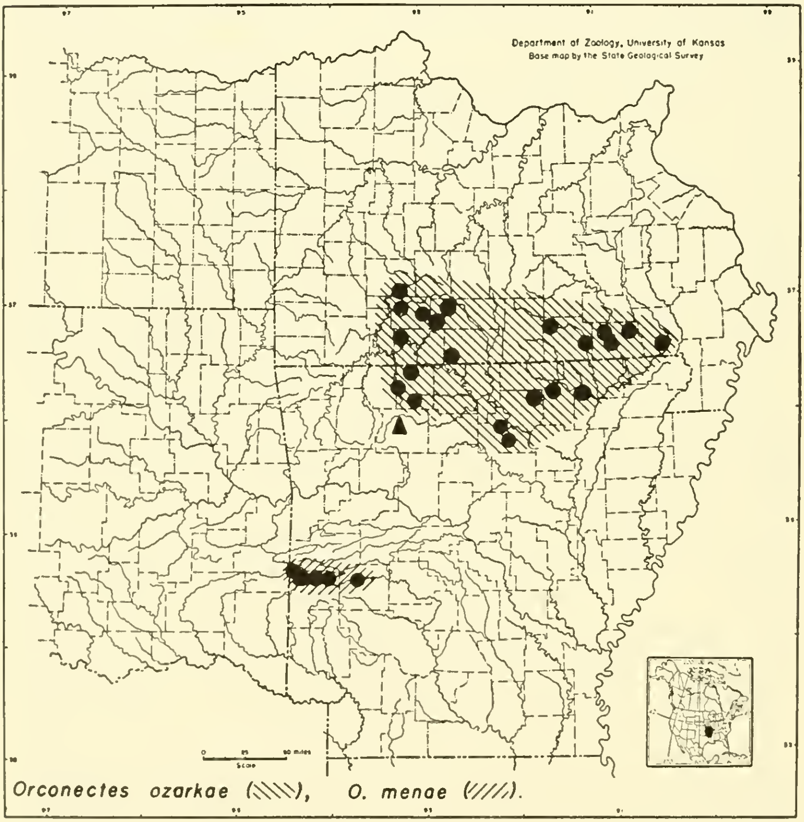

Department of Zoology, University of Kansas
Base map by the State Geological Survey
0 25 50 miles
Scale
Orconectes ozarkae (\\\\), O. menae (////).

FIG. 123. Distribution of *Orconectes ozarkae* and *O. menae* in the Ozark Plateaus and Ouachita Provinces.

Orconectes menae (Creaser)

Figs. 123-131

Faxonius menae Creaser, Occ. Pap. Mus. Zool., Univ. Michigan, No. 275, 1933, p. 5, figs. 9-10. (Type locality; Tributary of Irons Fork of Ouachita River at Mena, Polk County, Arkansas.)
Orconectes menae, Hobbs, Amer. Midl. Nat., Vol. 28, No. 2, 1942, p. 350.

Recognition characters: Male form I: Rostrum (fig. 142) widest at base with sides converging to blunt lateral spines, acumen short; postorbital ridges each terminating anteriorly in a distinct spine; cephalothorax subovate, depressed, laterally compressed; cephalic groove interrupted laterally, branchiostegal spine absent; areola with three rows of punctations at narrowest point; antennae shorter than body; antennal scale (fig. 144) evenly rounded mesially, widest at point anterior to mid-length; chelae (fig. 145) punctate, palm and proximal portion of movable finger with ciliated tubercles mesially, fingers slightly agape; carpus with ciliated tubercles dorsomesially, with single prominent spine and occasionally one to four small tubercles mesially; anterior process of epistoma triangular; ischius of third pair of pereiopods each with a hook.

Gonopods (figs. 124, 131) terminating in two elongate processes, tips of processes slightly curved caudad; lateral process (central projection) longer, corneous, with slight shoulder on cephalic surface near base; mesial process noncorneous, flattened distally; gonopod tips reaching base of second pereiopods with abdomen flexed.

Male form II: (figs. 125, 130).

Female: Annulus ventralis (fig. 127) with central area nearly circular in outline, surrounded by elevated margins on all sides; annulus divided longitudinally by sinuous fissure curving to deepest point in central portion of elevated area.

Color in life: (Male form I) Ground color fuscus; cephalic and abdominal regions overlaid with slight olive tinge; entire body maculate with olive; chelae fuscus dorsally, with olive maculations, fingers lightly tipped with orange; gill covers light pink ventrolaterally, cheeks light pink; pleurae fuscus laterally at joints; underparts off-white tinged with pink; chelae yellowish-orange ventrally, streaks of same color on uropods.

(Female) General color similar to male; annulus ventralis muddy azure blue.

Variations: This species exhibits individual variation in the length of the mesial process of the gonopods of the form I males. There is also a tendency for the mesial process of gonopods of both form

I and form II males to curve mesiad in the distal third or half of the process. Slight curves or twists occur in the central projection of the form I male gonopod.

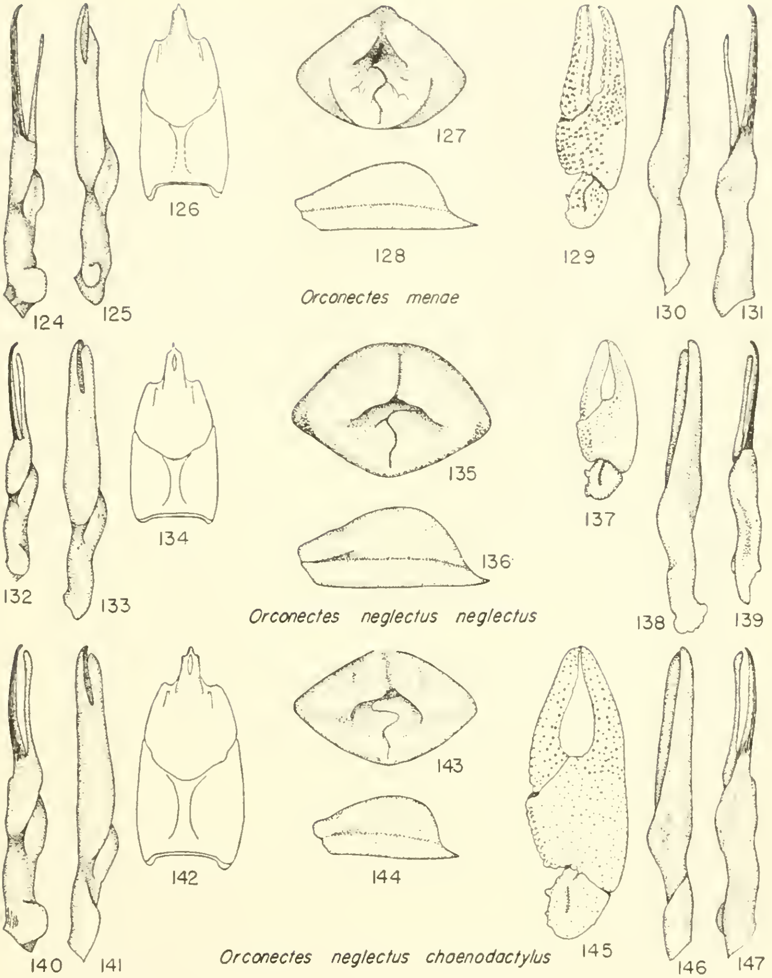
Ecological notes: Orconectes menae is found under rocks and rubble in stream beds. The species is found in both rapidly running and quiet water. Individuals are sometimes found in shallow burrows under rocks.

Orconectes menae is associated with *O. leptogonopodus, O. palmeri longimanus,* and perhaps with *Procambarus tenuis* and *P. vioscae* where these species occur within its range.

Species examined: One hundred fifty-eight as follows: ARKANSAS. *Montgomery County:* Lot 557. Little Brushy Creek ½ mi. E Oden; Lot 558. Ouachita River, 6 mi. NW Mount Ida; *Polk County:* Lot 543. Ouachita River, ½ mi. E Acorn; Lot 546. Tributary of Ouachita River at Mena; Lot 548. Irons Fork, 5$\frac{7}{10}$ mi. E Mena; Lot 551. Tributary of Ouachita River 4$\frac{6}{10}$ mi. E Ink; Lot 554. Tributary of Ouachita River, 2$\frac{1}{10}$ mi. E Cherry Hill; Lot 677. Small tributary of Mountain Fork River, 10 mi. WNW Mena; Lot 678. Rock Creek, 9 mi. W Mena; M53303. Stream tributary to Irons Fork of Ouachita River at Mena; Lot 811, 9½ mi. NW Mena. Paratypes at U.S.N.M.

Known range: The known range of this species is confined to the localities listed above.

Creaser designated specimens from Newton County, Arkansas (M53304) as conspecific with specimens from the Ouachita River near Mena, Polk County, Arkansas. Examination of the specimens in this lot of crayfishes reveals that there are six specimens in the lot, one adult form I male, two juvenile females and three juvenile males (all small). I have reached the conclusion that these specimens are not conspecific with *O. menae* but all are in reality specimens of *O. neglectus neglectus.* The one adult male is a freshly exuviated specimen which is somewhat distorted, but which exhibits some extremely peculiar characteristics in other respects. The specimen has gonopods, body shape, carinate rostrum and antennal scales which are shaped like those of *O. n. neglectus,* but the chelae are more like those of *O. meeki meeki* than they are like *O. n. neglectus.* One is tempted to call the specimen a hybrid. The smaller specimens are undoubtedly *O. n. neglectus.* Such a determination is further supported by two factors; (1) Recent collecting in Newton County has failed to show any *Orconectes menae* in the streams of that county; (2) The broad hiatus interposed by the Arkansas River


124
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Orconectes menae
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Orconectes neglectus neglectus
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Orconectes neglectus chaenodactylus

Orconectes menae. Lot 543; ½ mi. E Acorn, Polk County, Arkansas; 4 Sept. 1948. Fig. 124, ♂ I gonopod, mesial view; Fig. 131, ♂ I gonopod, lateral view; Fig. 125, ♂ II gonopod, mesial view; Fig. 130, ♂ II gonopod, lateral view; Fig. 126, Carapace; Fig. 127, Annulus ventralis; Fig. 128, Antennal scale; Fig. 129, Chela and carpus. *Orconectes neglectus neglectus.* Lot 775; 10 mi. S Alma, Wabaunsee County, Kansas; 30 Sept. 1950. Fig. 132, ♂ I gonopod, mesial view; Fig. 139, ♂ I gonopod, lateral view; Fig. 133, ♂ II gonopod, mesial view; Fig. 138, ♂ II gonopod, lateral view; Fig. 134, Carapace; Fig. 135, Annulus ventralis; Fig. 136, Antennal scale; Fig. 137, Chela and carpus. *Orconectes n. chaenodactylus.* Lot 442; $8\frac{9}{10}$ mi. SE Ava, Douglas County, Missouri; 23 Aug. 1948. Fig. 140, ♂ I gonopod, mesial view; Fig. 147, ♂ I gonopod, lateral view; Fig. 141, ♂ II gonopod, mesial view; Fig. 146, ♂ II gonopod, lateral view; Fig. 142, Carapace; Fig. 143, Annulus ventralis; Fig. 144, Antennal scale; Fig. 145, Chela and carpus.

Valley and southern slopes of the Boston Mountains makes conspecificity in specimens from these two localities seem quite remote.

Orconectes neglectus neglectus (Faxon)

Figs. 132-139; 148

Cambarus neglectus Faxon, Bull. Washburn College Lab. Nat. Hist., Vol. 1, No. 4, 1885, p. 142. (Type locality: Mill Creek, Wabaunsee County, Kansas.)

Orconectes neglectus, Hobbs, Amer. Midl. Nat., Vol. 28, No. 2, 1942, p. 350.

Recognition characters: Male form I: Rostrum (fig. 134) with nearly parallel sides, poorly defined lateral rostral spines, usually carinate; cephalic groove interrupted laterally; branchiostegal spine obsolescent; areola with four rows of punctations at narrowest point; antennae shorter than body, antennal scale (fig. 136) evenly rounded mesially, broadest anterior to mid-length, anterior spine moderately developed; chelae (fig. 137) heavy, deeply punctate dorsally and ventrally, fingers agape, gape less than 25 percent of width of palm; carpus usually with two blunt mesial spines, anterior one longest; anterior process of epistoma bell-shaped in outline; ischius of third pair of pereiopods each with a hook.

Gonopods (figs. 132, 139) ending in two elongate nearly straight processes; lateral process (central projection) longer, corneous, with rounded shoulder on cephalic surface near base; mesial process noncorneous, distal one third flattened, broadened near tip; tips of processes reach base of third pereiopods with abdomen flexed.

Male form II: (figs. 133, 138).

Female: Annulus ventralis (fig. 135) with median transverse sinus dipping under overhanging cephalic margin; annulus divided by sinuous median fissure curving to deepest point on either left or right of midsagittal plane.

Color in life: Ground color light green, light tan or yellow: conspicuous reddish markings on ridges, tubercles, and tips of chelae; black ring posterior to tips of chelae always present; chelae occasionally olive green dorsally; chelae with black streak on lateral margin; indefinite black splotches on posterolateral portion of cephalothorax; black markings on pleurae.

Variations: Regenerated chelae are relatively longer than normal, and the fingers are not agape. The most noticeable variations in *O. n. neglectus* are in the shape of the rostrum and the configuration of the annulus ventralis. Specimens from Douglas and Christian counties in Missouri tend to have shorter, broader rostra than the specimens from Kansas and extreme southwestern Missouri. Specimens from Green County, Missouri, and Newton County, Arkansas seem to be intermediate in this rostral character. Chelae in some Newton County, Arkansas forms are less robust than typical *O. n. neglectus.* Local populations in the region of Newton County, Arkansas seem more distinctive than the populations in southwestern Missouri and in Kansas. Configuration of the annulus ventralis varies throughout the range of the subspecies.

Ecological notes: Observations of various authors have been summarized by Williams and Leonard (1952:985). These authors all agree that *O. n. neglectus* is a species which lives in streams and rivers under rocks or in shallow burrows under rocks and boulders. The species apparently prefers clear water and a moderate to strong current. This species has never been collected from standing water in a pond, ditch or pool.

Orconectes neglectus neglectus is associated with *O. nana nana, O. nana macrus, O. ozarkae, O. meeki meeki, O. meeki brevis, O. longidigitus, O. nais, Cambarus hubbsi* and perhaps with *Orconectes palmeri longimanus* where these species occur within its range.

Specimens examined: Six hundred ninety-two as follows: Arkansas. *Benton County:* Lot 519. 1 mi. NW Sulphur Springs Lots 520 and 521. A small stream, ¼ mi. SE Gravette; Lot 522. A small creek 4½ mi. W Bentonville; *Boone County:* Lot 93. Bear Creek Springs, 7 mi. NW Harrison; Lot 94. Tributary of Bear Creek, ½ mi. N Lowry; Lot 648. Crooked Creek, 3⁴⁄₁₀ mi. S Harrison; Lot 650. Long Creek, ¾ mi. ESE Alpena Pass; Lot 722. Bear Creek, 1 mi. N Lowry; *Carroll County:* Lot 652. A small creek, 6⁷⁄₁₀ mi. WNW Green Forest; Lot 655. Kings River, 4⁴⁄₁₀ mi. WNW Berryville; Lot 788. A stream, 1½ mi. E Berryville on U. S. hy. no. 62; *Newton County:* Lot 638. Tributary of Big Creek, 7 mi. SE Jasper; Lot 641. Little Buffalo Creek, N city limits of Jasper; Lot 643. A small creek, 4 mi. SW Jasper; Lot 645. Buffalo River at Pruitt: *Stone County:* Lot 614. Sylamore Creek, ½ mi. NW Allison; *Washington County:* Lot 526. Clear Creek, 3 mi. SSW Springdale: Lot 667. Illinois River, 19 mi. SE Siloam Springs; Lot 670. Middle Fork, White River, 1¼ mi SE Baldwin. Missouri. *Barry County*: Lot 658. Shoal Creek, 2⁴⁄₁₀ mi. E Wheaton; Lot 738. Roaring River, 100 yd. N Roaring River Hotel, Roaring River State Park; Lot 791. Roaring River at State Fish Hatchery, 7 mi. S Cassville; *Christian County:* Lot 452. Swan Creek, ½ mi. S Keltner; Lot 457. Finley Creek at Ozark; Lot 719. Environs of Smallins Cave, 5 mi. SE Galloway; *Douglas County:* Lot 443. A small creek, 3 mi. NW Ava; Lot 445.

A small creek, 6 mi. NW Ava; Lot 448. Little Beaver Creek, 3½ mi. W Goodhope; *Greene County:* Lot 462. James River, 1 mi. S Galloway; *Jasper County:* Lot 484A. Center Creek, ½ mi. NE Sarcoxie; Lot 488A. Jenkins Creek, 7 7/10 mi. W Sarcoxie; Lot 490A. Spring River, ¼ mi. N Carthage; Lot 500. 4 mi. N Diamond; Lot 501. Dry Fork Creek, 5 7/10 mi. N Carthage; *Lawrence County:* Lot 492. Truitt Creek, 2 mi. N Mt. Vernon; Lot 495. Spring River, 2 mi. SW Mt. Vernon; *McDonald County:* Lot 515. Buffalo Creek, 1½ mi. SE Tiff City; Lot 516. Patterson Creek, 3 6/10 mi. SSE Tiff City: Lot 518. Elk River, 6 2/10 mi. S Tiff City. *Newton County:* Lot 494A. Branch of Shoal Creek at Hornet; 495A. Lost Creek at Seneca; 496A. Branch of Lost Creek, ½ mi. E. Seneca; Lot 498. Shoal Creek, 5 6/10 mi. NE Neosho; Lot 513. 1 8/10 mi. S Seneca;

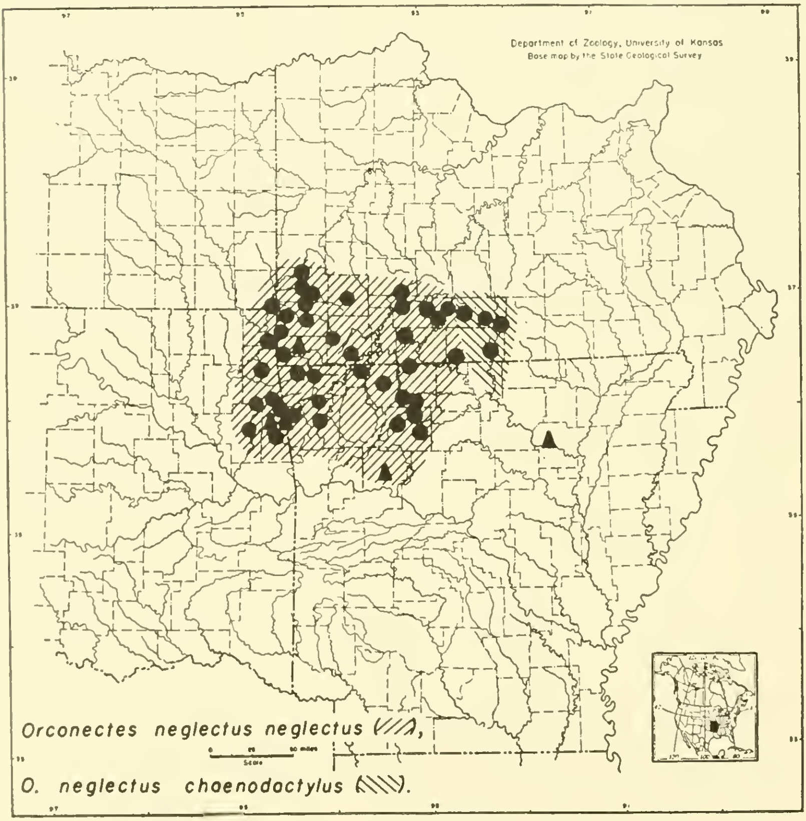

Department of Zoology, University of Kansas
Base map by the State Geological Survey
Orconectes neglectus neglectus (///),
O. neglectus choenodoctylus (\\\).

FIG. 148. Distribution of *Orconectes neglectus neglectus* and *O. n. chaenodactylus* in the Ozark Plateaus and Ouachita Provinces.

Ozark County: Lot 713. Little North Fork Creek at Theodosia; *Taney County:* Lot 717. Bear Creek, ½ mi. NW Walnut Shade. KANSAS. *Cherokee County:* Lot 660 and others. 5 mile Creek, 5 mi. E Baxter Springs. OKLAHOMA. *Adair County:* Lot 815. Stream 5 mi. N Stilwell; Lot 817. Illinois R., approximately 4 mi. N Westville; Lot 837. 2 7/10 mi. N U. S. Hy. no. 62 on Tyner Creek; *Delaware County:* Lot 661. Little Spring Creek, 3 mi. W Kansas; Lot 663. Flint Creek, 5 mi. E Kansas; Lot 819. 5 mi. N Junction Hys. no. 59 and 10; *Ottawa County:* Lot 763. Tributary of Lost Creek, 5 mi. N Turkey Ford; Cotypes in MCZ.

Additional records: ARKANSAS. *Independence County:* Batesville; *Johnson County:* Spring Creek; *Washington County:* Prairie Grove; Fayetteville. MISSOURI. *Greene County:* Galloway Cave [Sequiota Cave], Galloway; *Jasper County:* Day Brook; *McDonald County:* U.S.N.M. 22342. Indian Creek. *Newton County:* U.S.N.M. 44766. Neosho. OKLAHOMA. Adair County: Tyner Creek, 13½ mi. SW Westville; Courthouse Creek, 9 mi. SW Westville; *Cherokee County:* Illinois River near Tallequah; *Delaware County:* Honey Creek, 8 mi. S Grove; *Ottawa County:* Sycamore Creek, 3 mi. S. Grove.

Known range: This subspecies is known from the above localities, from an isolated population in Wabaunsee and Riley Counties in Kansas, and was formerly reported from northeastern Colorado and northwestern Kansas.

Orconectes neglectus chaenodactylus Williams

Figs. 140-148

Orconectes neglectus chaenodactylus Williams, Trans. Kansas Acad. Sci. Vol. 55, No. 2, 1952, p. 344, figs. 33-40. (Type locality: Whites Creek, 8 6/10 mi. SE Ava, Douglas County, Missouri.)

Recognition characters: Male form I: Rostrum (fig. 142) with sides subparallel, slightly sinuous, slightly divergent at base, excavate dorsally, deepest in basal half, carinate dorsally, acumen subtriangular, tip acute, lateral spines small, blunt; cephalothorax subovate, depressed; cephalic groove nearly continuous laterally; branchiostegal spine absent; areola with sides subparallel, with three rows of punctations at narrowest point; antennae shorter than body; antennal scale (fig. 144) evenly rounded mesially, widest anterior to mid-length, terminating in heavy anterior spine; chelae (fig. 145) broad; fingers with gape wider than 25 percent of width of palm; palm moderately flattened; palm and fingers conspicuously punctate on all surfaces, punctations forming rows on fingers; palm with double row of ciliated squamous tubercles mesially bounded by scattered small squamous tubercles dorsally; movable finger with obsolescent single row of ciliated squamous tubercles mesially; fingers with single row of nearly obsolescent tubercles on opposed edges; carpus with broad longitudinal groove dorsally, a blunt spine mesially, and an anterior and a posterior mesial tubercle; anterior process of epistoma bell shaped; ischius of third pair of pereiopods each with a strong hook.

Gonopods (figs. 140, 147) terminating in two elongate processes; lateral process (central projection) longer, corneous, bladelike, curved slightly caudad at tip; mesial process noncorneous, flattened, dilated near tip, with shallow longitudinal groove on mesiocephalic border, tip curved mesiad; tips of gonopods reach base of second pereiopod with abdomen flexed.

Male form II: (figs. 141, 146.)

Female: Annulus ventralis (fig. 144) ovoid, firmly fused to sternum, central sinus subtriangular, skewed, deep, cephalic margins flattened, divided by a shallow broad longitudinal groove bounded laterally by ridges, lateral margins broad with transverse broad shallow groove, caudal margin inflated and with sinus divided by a sinuous fissure.

Color in life: Ground color dark green, yellowish-green or flesh-pink; dark band on posterior portion of cephalothorax; hands dark green or pinkish, distal portion of fingers with reddish band in pinkish individuals; tubercles on hand and carpus light yellow, some of spines and tubercles on carpus, merus, and large knob at base of movable finger bright orange-red; epistoma bright orange-red; posterior edges of tergae with dark greenish bands.

Variations: The most evident variations in this subspecies are the relative development of the gape of the fingers and the thickness of the fingers. Some individuals have thick fingers with a moderate gape, while other individuals have attenuate fingers with an extremely broad gape. Slight variations in the sculpture of the annulus ventralis occur.

Ecological notes: This species has been taken from under rocks, from burrows under rocks and from vegetation in streams.

Orconectes neglectus chaenodactylus is associated with *O. punctimanus, O. longidigitus,* and perhaps with *O. ozarkae, O. nais* and *Cambarus hubbsi* where these species occur within its range.

Specimens examined: One hundred fourteen as follows: MISSOURI. *Douglas County:* Lot 429. Spring Creek, 19 7/10 mi. WNW West Plains: Lot 434. North Fork of White River, 20 mi. WNW West Plains; Lot 436. Brush Creek, 25 mi. SE Ava; Lot 437. Fox Creek, 22 3/10 mi. SE Ava; Lot 439. Bryant Creek, 14 8/10 mi. SE Ava; Lot 442. Whites Creek, 8 6/10 mi. SE Ava; *Ozark County:* Lot 711. N. Fork, White River at Tecumseh; *Texas County:* M53309. N. Fork White River, 9 mi. SW Cabool.

Known range: The known range of this subspecies is confined to the localities listed above.

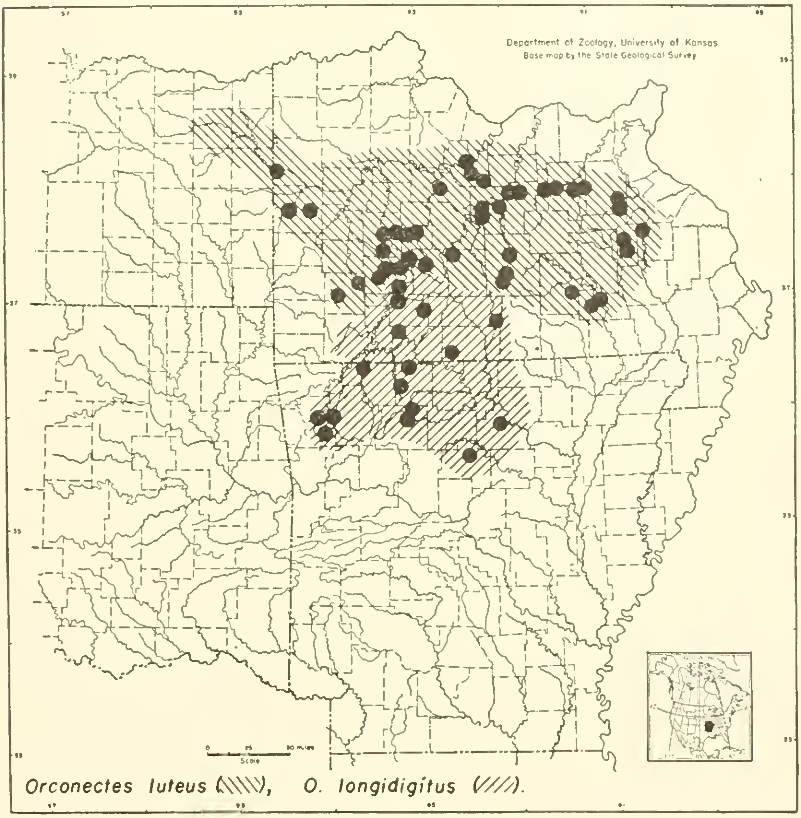

Department of Zoology, University of Kansas
Base map by the State Geological Survey
Scale
Orconectes luteus (\\\\), O. longidigitus (////).

FIG. 149. Distribution of *Orconectes luteus* and *O. longidigitus* in the Ozark Plateaus and Ouachita Provinces.

Orconectes luteus (Creaser)

Figs. 149-157

Cambarus juvenilis Hagen [*partim*], Illus. Cat. Mus. Comp. Zool., No. 3, 1870, p. 67.

Cambarus rusticus, Faxon [*partim*], Mem. Mus. Comp. Zool., Vol. 10, No. 4, 1885, p. 113. Faxon, Proc. U. S. Nat. Mus., Vol. 12, 1890, p. 632. Faxon, Proc. U. S. Nat. Mus., Vol. 20, 1898, p. 658. Steele, Pub. Univ. Cincinnati Bull. No. 10, Ser. 2, Vol. 2, 1902, p. 28.

Cambarus rusticus, Harris, Univ. Kansas Sci. Bull., Vol. 1, No. 1, 1902, p. 8.

Faxonius luteus Creaser, Occ. Pap. Mus. Zool., Univ. Michigan No. 275, 1933, p. 7, figs. 3-4. (Type locality: Nianguà River at mouth of Greasy Creek, 5 mi. SE Buffalo, Dallas County, Missouri.)

Orconectes luteus, Hobbs, Amer. Midl. Nat., Vol. 28, No. 2, 1942, p. 350.

Recognition characters: Male form I: Rostrum (fig. 152) widest at base with sides converging to distinct lateral spines, sometimes carinate dorsally, acumen approximately one-third as long as rostrum; postorbital ridges each terminating anteriorly in a distinct spine; cephalothorax subovate; cephalic groove interrupted laterally; branchiostegal spine distinct; areola with three or four rows of punctations at narrowest point; antennae longer than body; antennal scale (fig. 157) unevenly rounded mesially, widest at point anterior to mid-length; chelae (fig. 153) punctate, fingers agape; carpus usually with single mesial spine; anterior process of epistoma roughly triangular with distinct but rounded apical point; ischius of third pereiopods each with a hook.

Gonopods (figs. 150, 155) terminating in two elongate, more or less straight processes, lateral process (central projection) longer, corneous, curved caudad at tip, with distinct but rounded shoulder on cephalic surface near base; mesial process noncorneous, flattened distally; gonopod tips reaching base of third pereiopods with abdomen flexed.

Male form II: (figs. 151, 154).

Female: Annulus ventralis (fig. 156) subelliptical, with deep transverse sinus bordered anteriorly by elevated margin; annulus divided longitudinally by sinuous fissure curving to deepest point to right or left of median sagittal plane.

Color in life: Ground color a light olive-green with undertone of yellow on large areas on dorsal side of chelae, rostrum and sides of branchiostegites; dark band on posterior margin of head, near articulations of pleurae, on tergae dorsally, and on outer margin of hands; all dorsal tubercles, ridges and spines brick-red; fingers tipped with brick-red, almost scarlet; orange spot on cheeks below eyes; all joints, tubercles and spines on ventral aspect vary from light orange to dark orange; underside of hands, legs and sternum off-white; all colors darker in individuals which have not molted recently.

Variations: Orconectes luteus shows a great deal of variation in different parts of its geographic range, but like other species (*O. nais* for example) this variation is not constant. The same kinds of variation occur at widely scattered localities. The main difficulty at present is lack of sufficient material to assess adequately the geographical variations shown by these populations.

Specimens from the Gasconade River drainage show the development of chelae which are more robust than in typical *luteus.* Specimens from the Meramec River show development of a minute second mesial carpal spine and have mesial tubercles which are more prominent than in typical *luteus;* however the specimens examined are all small and may not reflect truly adult characters. Specimens from this drainage also show marked departures from the typical in the shape of the annulus ventralis. Specimens from the Sac River in Green, Lawrence and Polk Counties (Missouri) show development of even heavier chelae than is characteristic of the specimens from the Gasconade River.

More adequate collections in the future will probably show that this species is composed of a number of subspecific groups which intergrade either in the headwaters or in the lower stretches of the streams.

Ecological notes: Ecological observations on *O. luteus* have been summarized by Williams and Leonard (1952:990). This species lives for the most part in clear or moderately turbid streams under rocks or debris, however the species is found in streams which must carry a considerable load of silt at certain times of the year. *Orconectes luteus* constructs shallow burrows under rocks in the stream beds.

Orconectes luteus is associated with *O. harrisonii, O. quadruncus, O. peruncus, O. hylas, O. punctimanus, O. medius, O. hylas,* and perhaps with *O. ozarkae* and *Cambarus hubbsi* where these species occur within its range.

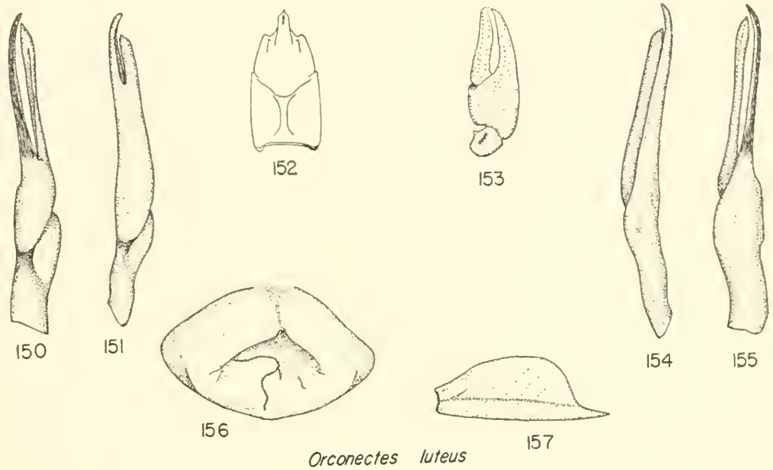
Specimens examined: Approximately five hundred sixty as follows: MISSOURI. *Bates County:* Lot 512. Osage River 1½ mi. NW Worland; *Camden County:* M53317. Tributary to Niangua River at Hahatonka; *Carter County:* Lot 395. Current River at Van Buren; M53313. Pikes Creek, 3 mi. SW Van Buren; M53314. Long Bay, 2½ mi. S Big Spring State Park; *Crawford County:* Lot 350. Meramec River, 12 mi. W Steelville; Lot 352. Huzzah Creek, 8 mi.

E Steelville; Lots 354 and 355. Courtois Creek, 16 mi. E Steelville; *Dallas County:* Lot 468. A small creek, 8 8/10 mi. SSW Buffalo; Lot 469. Greasy Creek, 5 mi. SE Buffalo; Lot 471. Linley Creek, 4 mi. W Buffalo; *Greene County:* Lot 464. Little Sac River, 10 mi. N Springfield; Lot 465. Pomme de Terre River, 15 3/10 mi. NNE Springfield; Lot 481. Little Dry Sac River, 1 7/10 mi. S Glidewell; Lot 484. A small creek, 11½ mi. W Springfield; Lot 487. Pickerel Creek, 10 7/10 mi. W Springfield; *Iron County:* Lot 373. Stouts Creek at Ironton; Lot 376. Stouts creek 2 3/10 mi. E Arcadia; Lot 377. Stouts Creek, 2 3/10 mi. NE Hogan; Lot 384. Tributary of Big Creek at Chloride; M53311. Ruble Spring Branch and Big Creek; *Lawrence County:* Lot 489. Billies Creek, ¼ mi. W Halltown; Lot 491. Turnback Creek, 2 1/10 mi. W Halltown; Lot 480A. Spring River, 2 mi. SW Mt. Vernon; M53316. Johnson Creek near Halltown; *Madison County:* M53309. Little St. Francis River, 9 mi. E Ironton; *Miller County:* Lot 334. 1 7/10 mi. SW Tuscumbia; Lot 336 1 6/10 mi. SE Tuscumbia; Lot 338. 7 mi. SE Tuscumbia (on Mo. hy. no. 17); Lot 339. Tavern Creek, 3 7/10 mi. S Iberia (on Mo. hy. no. 17); *Oregon County:* Lot 423. Eleven Point River at Riverton; *Phelps County:* Lot 345. Gasconade River, ¼ mi. N Jerome; Lot 347. Little Beaver Creek, 4½ mi. W Rolla; Lot 348. Dry Fork Creek, 3 mi. SE St. James; *Polk County:* Lot 474. Hominy Creek, ½ mi. E Half Way; Lot 476. Pomme de Terre River, Burns: Lot 477. Piper Creek, 1 mi. E Bolivar; Lot 480. North Dry Sac River, 2 mi. S Brighton; *Pulaski County:* Lot 341. Roubidoux Creek, ¼ mi. SE confluence with Gasconade River; Lot 343. Big Piney River, 8 mi. NE Waynesville; M53308 Roubidoux Creek at Waynesville; *Ripley County:* Lot 415 Current River at Doniphan; Shannon County: M53315. Rocky Creek, 9 mi. NE Winona; *Texas County:* M53319. Big Piney River, 6 mi. S Houston; M53321. Potters Creek, 3 mi. NE Cabool; M53322. Beeler Creek, 3 mi. SE Cabool; *Vernon County:* Lot 505. Big Drywood Creek, 5 6/10 mi. W Nevada; Lot 506. Clear Creek, 12 mi. E Nevada; *Washington County:* Lot 357. Fourche a Renault Creek at Shirley: Lot 364. Irondale; Lot 366. Cedar Creek, 2 mi. SW Irondale; Lot 369. Cedar Creek, 1½ mi. SE Caledonia; M53312. Stream at Irondale; *Webster County:* M53323. Headwaters of Niangua River near Marshfield; *Wright County:* M53318. Smittles Cave, 20 mi. S Lebanon; Paratypes in U.S.N.M.

Additional records: ARKANSAS. *Carroll County:* White River, Eureka Springs[?]; *Lawrence County:* Black River, Black Rock.

Missouri. Osage River; *Greene County:* Springfield, Galloway Cave [Sequiota Cave], Galloway; *Webster County:* Marshfield.

Known range: The known range of this species is confined to the above localities in Missouri and Arkansas, but the range extends into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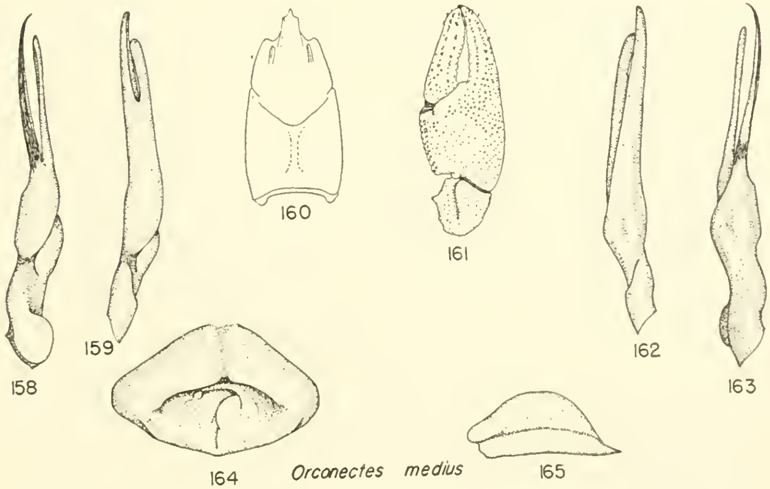
Orconectes luteus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Orconectes medius

Orconectes luteus. Lot 469; 5 mi. SE Buffalo, Dallas County, Missouri; 25 Aug. 1948. Fig. 150, ♂ I gonopod, mesial view; Fig. 155, ♂ I gonopod, lateral view; Fig. 151, ♂ II gonopod, mesial view; Fig. 154, ♂ II gonopod, lateral view; Fig. 152, Carapace; Fig. 153, Chela and carpus; Fig. 156, Annulus ventralis; Fig. 157, Antennal scale. *Orconectes medius.* Lot 357; Shirley, Washington County, Missouri; 18 Aug. 1948. Fig. 158, ♂ I gonopod, mesial view; Fig. 163, ♂ I gonopod, lateral view; Fig. 159, ♂ II gonopod, mesial view; Fig. 162, ♂ II gonopod, lateral view; Fig. 160, Carapace; Fig. 161, Chela and carpus; Fig. 164, Annulus ventralis; Fig. 165 Antennal scale.

Kansas in the Marais des Cygnes River. In my opinion however, the record from Carroll County, Arkansas is doubtful. Recent collections have failed to show any *O. luteus* in this area.

Orconectes medius (Faxon)

Figs. 158-166

Cambarus medius Faxon, Proc. Amer. Acad. Art. and Sci., Vol. 20 No. 7, 1885, p. 121. (Type locality: Irondale, Washington County, Missouri.)
Orconectes medius, Hobbs, Amer. Midl. Nat., Vol. 28, No. 2, 1942, p. 350.

Recognition characters: Male form I: Rostrum (fig. 160) with sides subparallel, slightly divergent at base, acumen subtriangular, short, lateral spines reduced, rounded; postorbital ridges each terminating anteriorly in an indistinct tubercle; cephalothorax ovate; cephalic groove interrupted laterally, branchiostegal spine greatly reduced, blunt; areola with sides indistinct, subparallel, with four rows of punctations at narrowest point; antennae shorter than body; antennal scale (fig. 165) evenly rounded mesially, widest anterior to mid-length, chelae (fig. 161) robust, conspicuously punctate on all surfaces, fingers agape, with heavy setiferous punctations dorsally forming rows separated by ridges, palm with double row of squamous tubercles mesially; carpus punctate, with strong blunt mesial spine and a reduced anterior and posterior mesial tubercle; anterior process of epistoma bell-shaped; ischius of third pereiopods each with a hook.

Gonopods (figs. 158, 163) terminating in two elongate processes: lateral process (central projection) corneous, thin, bladelike, curved caudad at less than angle of 45 degrees with axis of shaft, shoulder on cephalic surface at base; mesial process noncorneous, with shallow longitudinal troughlike groove on cephalic surface distally; tips of gonopods reach base of first pair of pereiopods with abdomen flexed.

Male form II: (figs. 159, 162).

Female: Annulus ventralis (fig. 164) with margins inflated, cephalic margin overhanging laterally elongate central sinus, annulus divided in caudal half by a sinuous longitudinal fissure curving to deepest point in cephalic portion of sinus.

Variations: Creaser (1934:3) noted that the length of the lateral spines on the rostrum of *Orconectes medius* varies considerably. This species in many respects is very close to *O. luteus*. These similarities extend to all of the usually distinguishing characters including similar gonopods, annulus ventralis, antennal scale, chelae, postorbital ridges and cephalothorax shape. However these similarities are not shared by these two species within the range of *O. medius*, and where populations of *O. luteus* which resemble *O. medius* do occur, a gradient from typical *O. luteus* is observable.

Ecological notes: Orconectes medius occurs in streams under rocks. The species is associated with *O. harrisonii, O. hylas, O. punctimanus, O. luteus,* and *Cambarus hubbsi* where these species occur within its range.

Specimens examined: Thirty-six as follows: MISSOURI. *Washington County:* Lot 357. Fourche a Renault Creek at Shirley: Lot 359. Mine a Breton Creek, 3 mi. SW Potosi; Types at M.C.Z.

Additional records: MISSOURI. *Dent* and *Crawford Counties* in

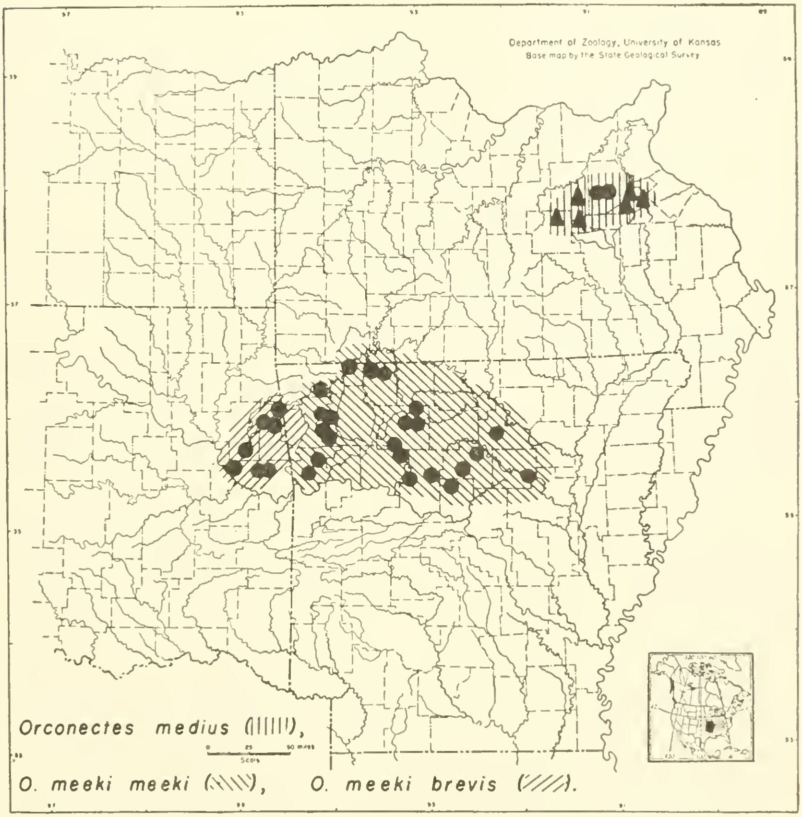

Department of Zoology, University of Kansas
Base map by the State Geological Survey
Orconectes medius (|||||),
O. meeki meeki (\\\\\),
O. meeki brevis (/////).
Scale

FIG. 166. Distribution of *Orconectes medius, O. meeki meeki* and *O. m. brevis* in the Ozark Plateaus and Ouachita Provinces.

the headwaters of the Meramec River; *St. Genevieve* and *Washington Counties* in the headwaters of the Big River.

Known range: The known range of this species is confined to the localities listed above.

Orconectes meeki meeki (Faxon)

Figs. 166-174

Cambarus meeki Faxon, Proc. U. S. Nat. Mus., Vol. 20, No. 1136, 1898, p. 657, pl. 65, figs. 5-9. (Type locality: Walnut Fork of Big Piney Creek, Swain, Newton County, Arkansas.)

Orconectes meeki, Hobbs, Amer. Midl. Nat., Vol. 28, No. 2, 1942, p. 350.

Recognition characters: Male form I: Rostrum (fig. 169) with sides subparallel, converging anteriorly, sides divergent at base, acumen with tip strongly projected dorsally. Lateral spines distinct; postorbital ridges each terminating anteriorly in a blunt spine; cephalothorax subcylindrical; cephalic groove slightly interrupted laterally, branchiostegal spines distinct; areola with three rows of punctations at narrowest point; antennae shorter than body; antennal scale (fig. 174) evenly rounded mesially, widest anterior to midlength; chelae (fig. 170) broad, fingers slender, palm and fingers with deep setiferous punctations on all surfaces, fingers ridged dorsally; carpus with two prominent spines mesially and a varying number of tubercles mesially; anterior process of epistoma rounded anteriorly; ischius of third pereiopods each with a hook.

Gonopods (figs. 167, 172) terminating in two elongate processes; tips of both processes curved caudad at less than 45 degree angle with axis of shaft; lateral process (central projection) longer, corneous; mesial process noncorneous, flattened and broadened distally with shallow longitudinal troughlike groove on cephalic surface.

Male form II: (figs. 168, 171).

Female: Annulus ventralis (fig. 173) subrhomboid in outline; margins greatly inflated; annulus incompletely divided by a sinuous longitudinal fissure curving into a small deep sinus in cephalic portion.

Color in life: General body color fuscus, chelae fuscus; cephalothorax and chelae mottled with dark olive dorsally, maculations larger and less numerous on anterior region of cephalothorax; tinge of blue or bluish-green on distal half of fingers and on all legs dorsally; basal segments of antennae olive-green; tips of fingers orange, all joints on hands and legs scarlet-orange, margins of tergae scarlet-orange to purplish-red, slight pinkish tinge on cheek, lateral side of cephalothorax and on pleurae, orange stripe on lateral side of chelae; underparts off-white to buff.

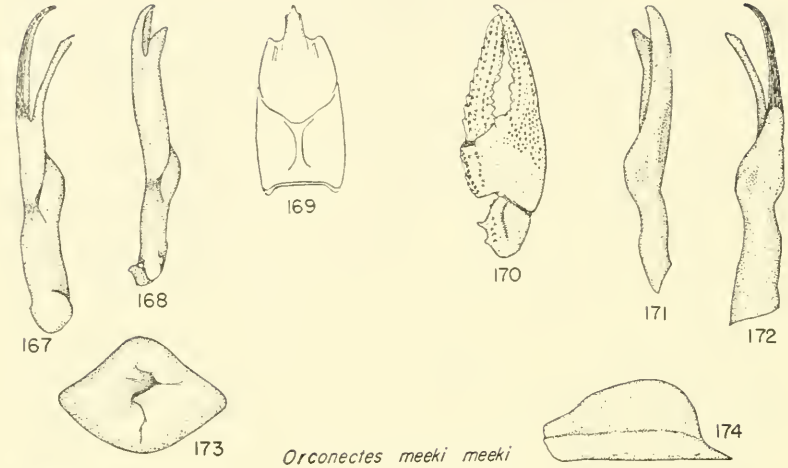
Annulus ventralis may have bluish green tinge. Recently molted individuals and juveniles have fuscus ground color.

Variations: Faxon (1898:657) described *O. meeki meeki* as having strongly upturned rostral spines, and Ortmann (1905:112) used this character in a key. This character is valid in a majority of the individuals examined, but the character is variable in a great enough percentage of the individuals to be misleading unless a good series is available for study. The rostrum varies greatly in width individually. Some specimens (usually those with a wide rostrum) tend to have a carinate rostrum. The sides of the rostrum vary, being concave in some individuals and straight in others.

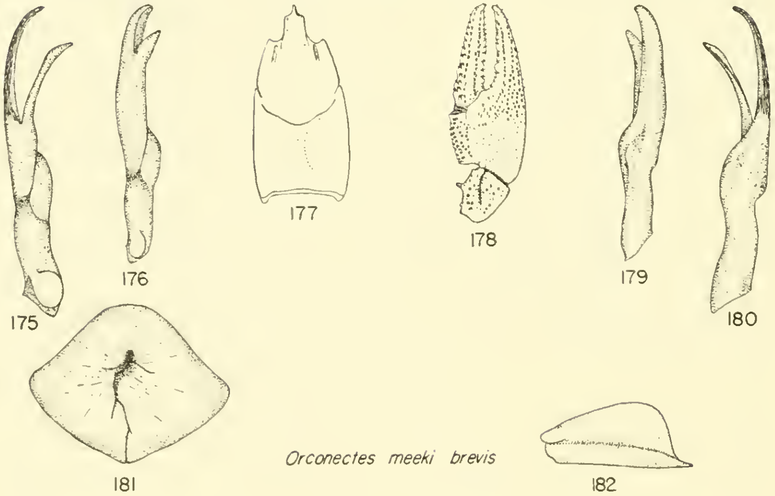
Ecological notes: This species occurs under rocks and debris in the water, and in burrows under rocks. The species lives in rapid water in the White River and its tributaries, and in similar streams in the Arkansas River drainage, but it also occurs in muddy algae-choked pools and even in stagnant situations in the lower reaches of streams tributary to the Arkansas River. Numerous burrows which were assumed to be constructed by this species were noted in the muddy banks of these streams.

Orconectes meeki meeki is associated with *O. ozarkae, O. neglectus neglectus, O. longidigitus, O. nais,* and *O. palmeri longimanus* where these species occur within its range.

Specimens examined: Three hundred fifty-four as follows: ARKANSAS. *Benton County:* Lot 524. A small creek 5 8/10 mi. S Rogers; Lot 525. A small creek, 8½ mi. S Rogers; *Carroll County:* Lot 653. A small creek, 6 2/10 mi. WNW Green Forest; Lot 656. Spider Creek and White River, 10½ mi. NW Eureka Springs; Lot 787. A stream 1½ mi. E Berryville on U. S. hy. no. 62; Lot 789. Spider Creek, 6 mi. W White River on U. S. hy. no. 62; *Clayburne County:* Lot 580. Tributary of Big Creek, 3 3/10 mi. NE Hogan; Conway County: Lot 626. W Fork Point Remove Creek, 3 4/10 mi. WSW Cleveland; *Crawford County:* Lot 532. Jones Creek, 2½ mi. NNE Mountainburg; Lot 838. Tributary of Arkansas River, 5 7/10 mi. SW Alma; *Johnson County:* Lots 633, 634, and 793. Little Piney Creek, 1½ mi. SE Mt. Levi; Lots 635 and 636. Haw Creek, 3 9/10 mi. NE Mt. Levi; Lot 637. Gee Creek, 6 2/10 mi. NE Mt. Levi; *Newton County:* Lot 639. Tributary of Big Creek, 7 mi. SE Jasper; Lot 640. Little Buffalo Creek, N city limits of Jasper; Lot 644. A small creek, 4 mi. SW Jasper; Lot 786A. Stream emerging from cave, ¼ mi. S Marble Falls; Lot 786B. Tributary of Buffalo River, 1 7/10 mi. N Jasper on Arkansas hy. no. 7; *Pope County:* Lot 629. A small creek, 9 6/10 mi. NW Moreland; Lot 631. Illinois Bayou, 1 mi. NW Dover; Lot



Orconectes meeki meeki



Orconectes meeki brevis

Orconectes meeki meeki. Lot 635; 4 mi. NE Mt. Levi, Johnson County, Arkansas; 13 Sept. 1948. Fig. 167, ♂ I gonopod, mesial view; Fig. 172, ♂ I gonopod, lateral view; Fig. 168, ♂ II gonopod, mesial view; Fig. 171, ♂ II gonopod, lateral view; Fig. 169, Carapace; Fig. 170, Chela and carpus; Fig. 173, Annulus ventralis; Fig. 174, Antennal scale. *Orconectes meeki brevis.* Lot 814, 5 mi. N Stilwell, Adair County, Oklahoma; 25 Mar. 1951. Fig. 175, ♂ I gonopod, mesial view; Fig. 180, ♂ I gonopod, lateral view; Fig. 176, ♂ II gonopod, mesial view; Fig. 179, ♂ II gonopod, lateral view; Fig. 177, Carapace; Fig. 178, Chela and carpus; Fig. 181, Annulus ventralis; Fig. 182, Antennal scale.

632. Big Piney Creek, $9\frac{6}{10}$ mi. NNW Dover; *Stone County:* Lot 618. A small creek, $11\frac{3}{10}$ mi. SW Mountain View; Lot 620. Turkey Creek, $13\frac{9}{10}$ mi. SW Mountain View; *Van Buren County:* Lot 622. Tributary of Middle Fork, 2 mi. SW Shirley; Lot 624. Pee Dee Creek, $7\frac{7}{10}$ mi. SW Shirley; Lot 625. South Fork Little Red River, $8\frac{7}{10}$ mi. SW Clinton; *Washington County:* Lot 528. Tributary of West Fork, Greenland; Lot 529. Tributary of West Fork, $2\frac{6}{10}$ mi. S Greenland; Lot 530. Tributary of West Fork, $2\frac{6}{10}$ mi. SSE West Fork; Lot 531. Tributary West Fork, 7½ mi. SE West Fork; Lot 669. Middle Fork, White River, 1¼ mi. SE Baldwin; Lot 673. On and near Middle Fork, White River, $5\frac{4}{10}$ mi. S Sulphur City; Types M.C.Z., Paratypes U.S.N.M.

Additional records: ARKANSAS. Walnut Fork, Piney [Creek]; [*Washington County*]: Fayetteville. MISSOURI. *Stone County:* U.S.N.M. 62310. Galena.

Known range: The known range of this subspecies is confined to the localities listed above.

Orconectes meeki brevis Williams

Figs. 166; 175-182

Orconectes meeki brevis Williams, Trans. Kansas Acad. Sci. Vol. 55, No. 2, 1952, p. 348, figs. 41-48. (Type locality: A stream approximately 5 mi. N Stilwell, on U. S. highway number 59, Adair County, Oklahoma.)

Recognition characters: Male form I: Rostrum (fig. 177) with sides subparallel, divergent at base, excavate dorsally, carinate dorsally, acumen short, subtriangular, lateral spines obsolescent; postorbital ridges short, each terminating anteriorly in an obsolescent spine; cephalothorax subovate, slightly depressed; cephalic groove interrupted laterally, branchiostegal spine greatly reduced, blunt, ciliated; areola with sides subparallel, with two rows of punctations at narrowest point; antennae shorter than body; antennal scale (fig. 182) evenly rounded mesially, widest anterior to midlength; chelae (fig. 178) with fingers slightly agape, flattened, palm moderately inflated, with scattered small ciliated squamous tubercles mesiodorsally, slightly emarginate laterally, fingers with rows of punctations dorsally, separated by ridges; carpus with broad longitudinal groove dorsally and ciliated squamous tubercles mesiodorsally; and with well developed central spine, posterior spiniform tubercle, and anterior tubercle mesially; anterior process of epistoma roughly subtriangular; ischius of third pair of pereiopods each with a strong hook.

Gonopods (figs. 175, 180) terminating in two elongate processes, both curved caudad at nearly a 90 degree angle with axis of shaft; lateral process (central projection) longer, corneous, bladelike; mesial process noncorneous, flattened distally, with extremely shallow troughlike groove on cephalolateral surface, tip twisted slightly mesiad; tips of gonopods reaching base of second pereiopods with abdomen flexed.

Male form II: (figs. 176, 179).

Female: Annulus ventralis (fig. 181) subrhomboid in outline, firmly fused to sternum, margins greatly inflated; annulus incompletely divided by a sinuous longitudinal fissure curving into a small deep sinus in anterior portion.

Variations: The most conspicuous variations in this subspecies are in the shape of the rostrum and acumen, and in the relative development of the lateral rostral spines and the spines on the postorbital ridges. These spines tend to be reduced or nearly obliterated and the acumen tends to be short and blunt. A majority of the specimens have a relatively narrow rostrum with sides which converge anteriorly. However, a few individuals tend to be much like typical *O. meeki meeki*, with a broad rostrum possessing well-developed lateral spines, and with prominent spines on the postorbital ridges. Variation in the sculpture of the annulus ventralis occurs.

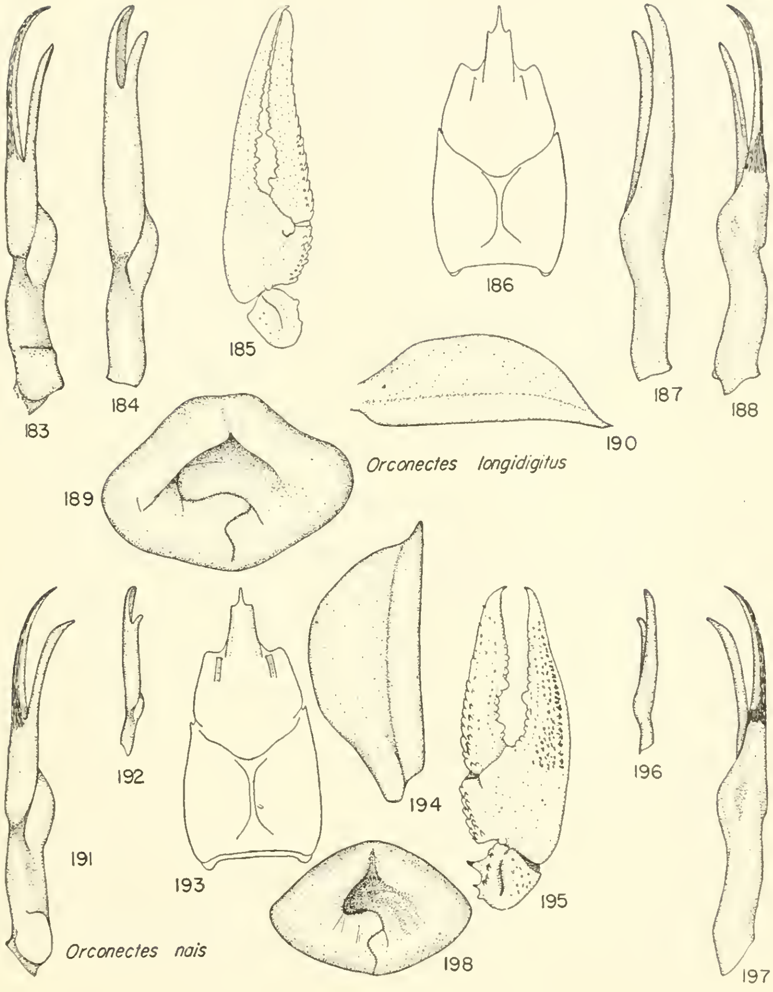
Ecological notes: This subspecies has been taken from under rocks, and from communal burrows under rocks in streams.

Orconectes meeki brevis is associated with *O. nana nana*, *O. neglectus neglectus* and perhaps with *O. nana macrus*, *O. nais*, and *O. palmeri longimanus* where these species occur within its range.

Specimens examined: Sixty-one as follows: OKLAHOMA. *Adair County:* Lot. 758. Tyner Creek, 2⅓ mi. N Proctor; Lot 814. A stream, approximately 5 mi. N Stilwell on U. S. hy. no. 59; Lot 816. Illinois River, approximately 4 mi. N Westville; *Cherokee County:* Lot 761. 2 mi. W Cookson; *Sequoyah County:* Lot 759. Stream, 6 mi. N Sallisaw; Lot 760. Swimmers Creek, 10 mi. N Gore: Lot 765. 3⁹⁄₁₀ mi. N Sallisaw on U. S. hy. no. 59; Lot 766. 1¹⁄₁₀ mi. W, 8⁷⁄₁₀ mi. N Sallisaw on U. S. hy. no. 59.

Additional records: ARKANSAS. *Benton County:* U.S.N.M. 58126, 58127, 58128. Gentry; *Washington County:* U.S.N.M. 74918. 4 mi. Summers.

Known range: The known range of this subspecies is confined to the localities listed above.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Orconectes longidigitus
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Orconectes nais

Orconectes longidigitus. Lot 451; ½ mi. S Keltner, Christian County, Missouri; 24 Aug. 1948. Fig. 183, ♂ I gonopod, mesial view; Fig. 188, ♂ I gonopod, lateral view; Fig. 185, Chela and carpus; Fig. 186, Carapace; Fig. 190, Antennal scale. Lot 612; ½ mi. NW Allison, Stone County, Arkansas; 11 Sept. 1948. Fig. 184, ♂ II gonopod, mesial view; Fig. 187, ♂ II gonopod, lateral view; Fig. 189, Annulus ventralis. *Orconectes nais.* Lot 122; 4 mi. W Chetopa, Labette County, Kansas; 6 Apr. 1947. Fig. 191, ♂ I gonopod, mesial view; Fig. 197, ♂ I gonopod, lateral view; Fig. 192, ♂ II gonopod, mesial view; Fig. 196, ♂ II gonopod, lateral view; Fig. 193, Carapace; Fig. 194, Antennal scale; Fig. 195, Chela and carpus; Fig. 198, Annulus ventralis.

Orconectes longidigitus (Faxon)

Figs. 149; 183-190

Cambarus longidigitus Faxon, Proc. U. S. Nat. Mus., Vol. 20, No. 1136, 1898, p. 653, pl. 62, figs. 6-9. (Type locality: Oxford Bend, White River [Izard County?], Arkansas.)

Cambarus whitmani Steele, Univ. Cincinnati Bull. 10, Ser. 2, Vol. 2, 1902, p. 24, pl. 3, figs. C_1, C_2.

Orconectes longidigitus, Hobbs, Amer. Midl. Nat. Vol. 28, No. 2, 1942, p. 350.

Recognition characters: Male form I: Rostrum (fig. 186) with sides nearly parallel, lateral spines distinct, acumen long, acute; postorbital ridges each terminating in an acute anterior spine; cephalothorax ovate; cephalic groove continuous laterally in mature individuals, slightly interrupted in juveniles, branchiostegal spine distinct; areola with sides not parallel, two rows of punctations at narrowest point; antennal scale (fig. 190) evenly rounded mesially, broadest at mid-length, distal one third curved laterad; chelae (fig. 185) extremely elongate, punctate, mesial border of palm and proximal two thirds of movable finger with double row of nearly pointed tubercles; carpus with one to three sharp spiniform mesial tubercles and an irregular number of smaller tubercles; anterior process of epistoma subtriangular, highly variable; ischius of third pereiopods each with a hook.

Gonopods (figs. 183, 188) ending in two elongate slightly curved processes; lateral process (central projection) corneous, longer, with slight shoulder on cephalic surface near base; mesial process noncorneous, distal one third flattened, bladelike; tips of processes reaching base of second pereiopods with abdomen flexed.

Male form II: (figs. 184, 187).

Female: Annulus ventralis (fig. 189) with median transverse sinus dipping under overhanging cephalic margin; annulus divided by sinuous longitudinal fissure curving to deepest point on either left or right of midsagittal plane, sculpture variable.

Color in life: Ground color dark green to yellowish-green; hands and fingers dark blue-green; tubercles on chela and carpus light yellow; some spines on carpus, merus, and hand at base of movable finger bright orange-red; bar at base of epistoma bright orange-red; dark greenish bands at caudal edge of tergal plates.

Variations: The length of the acumen and width of the rostrum show individual variations. The annulus ventralis shows modifications in sculpture. Faxon (1898:645) noted that there is frequently a disparity in size between the chelae of this species. I attribute this disparity in size to regenerated chelae. The regenerated chelae have regularly spaced tubercles on the opposed margins of the fingers. The tubercles are apparently conspicuous because of the large size of the chelae of this species. Many of the large individuals have malformed chelae with fingers either totally absent or bent into bizarre shapes. I attribute these malformations to the extreme length and slenderness of the chelae which presumably increase the probability of injury at the time of molting.

Ecological notes: Orconectes longidigitus occurs most abundantly in situations where large slabs of rock have fallen into streams or where streams have undercut rock outcrops leaving fissures and solution holes which extend back under the stream banks. The largest specimens apparently prefer deep holes or pools where there is adequate cover.

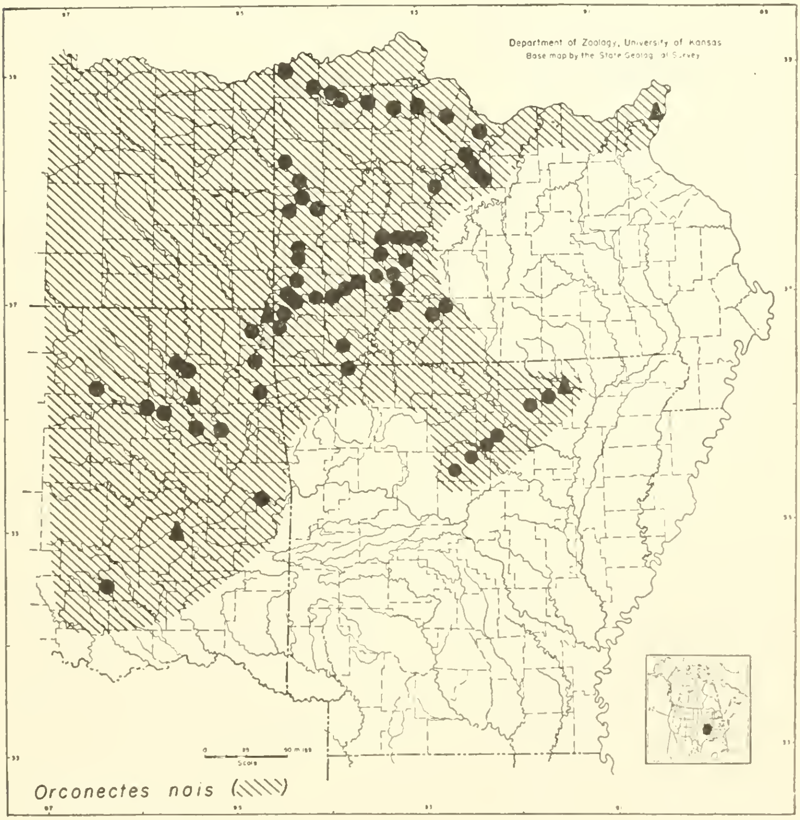

Department of Zoology, University of Kansas
Base map by the State Geological Survey
0 25 50 miles
Scale
Orconectes nais (▨)

FIG. 199. Distribution of *Orconectes nais* in the Ozark Plateaus and Ouachita Provinces.

This species is not markedly pugnacious when first aroused, but can become so if pursued. The individuals are rapid swimmers which do not tire as easily as some of the smaller species do.

Orconectes longidigitus is associated with *O. punctimanus, O. ozarkae, O. neglectus neglectus, O. neglectus chaenodactylus, O. meeki meeki, O. nais* and *Cambarus hubbsi* where these species occur within its range.

Specimens examined: One hundred twenty-nine as follows: Arkansas: *Boone County:* Lot 649. Long Creek, ¾ mi. ESE Alpena Pass; Lot 720. Bear Creek, 1 mi. N Lowry; *Carroll County:* Lot 654. Kings River, $4\frac{7}{10}$ WNW Berryville; *Newton County:* Lot 642. Little Buffalo Creek, N city limits of Jasper; Lot 646. Buffalo River at Pruitt; *Stone County:* Lot 612. Sylamore Creek, ½ mi. NW Allison; *Van Buren County:* Lot 621. Tributary of Middle Fork, 2 mi. SW Shirley; *Washington County:* Lot 668. Middle Fork, White River 1¼ mi SE Baldwin; Lot 671. White River, ½ mi. E Elkins; Lot 672. On and near Middle Fork, White River, $5\frac{4}{10}$ mi. S Sulphur City. Missouri. *Christian County:* Lot 451. Swan Creek, ½ mi. S Keltner; Lot 454. Finley Creek at Ozark; *Douglas County*: Lot 430. Spring Creek, $19\frac{7}{10}$ mi. WNW West Plains; Lot 432. North Fork of White River, 20 mi. WNW West Plains: *Greene County:* Lot 458. James River, 1 mi. S Galloway; *Ozark County:* Lot 712. Little North Fork Creek at Theodosia; *Taney County:* Lot 716. Bear Creek, ½ mi. NW Walnut Shade; Types M.C.Z.; Paratypes U.S.N.M.

Additional records: Arkansas. Oxford Bend, White River, [Izard County?]; Missouri. James River.

Known Range: The known range of this species is confined to the localities listed above.

Orconectes nais (Faxon)

Figs. 191-199

Cambarus nais Faxon, Bull. Washburn Coll. Lab. Nat. Hist. Vol. 1, No. 4, 1885, pp. 140-141. (Type locality: Labette County, Kansas.)
Cambarus virilis Hagen [*partim*], Illus. Cat. Mus. Comp. Zool., No. 3, 1870, p. 64. Faxon, Mem. Mus. Comp. Zool., Vol. 10, No. 4, 1885, p. 97.
Cambarus pilosus Hay, Proc. U. S. Nat. Mus., Vol. 22, 1899, p. 121, fig. 1.
Cambarus pelosus [*sic*] Harris, Trans. Kansas Acad. Sci., Vol. 17, 1901, p. 115.
Cambarus virilis Steele, Pub. Univ. Cincinnati Bull. No. 10, Ser. 2, Vol. 2, 1902, p. 32, pls. 1-2. Engle, Bull. U. S. Bur. Fish., Vol. 42, 1926, p. 91.
Orconectes nais, Hobbs, Amer. Midl. Nat., Vol. 28, No. 2, 1942, p. 350.

Recognition characters: Male form I. Rostrum (fig. 193) widest at base, sides converging to weakly developed lateral spines, acumen distinct, dorsal excavation deepest near base; postorbital ridges each terminating in low anterior spine; cephalothorax ovate; cephalic groove interrupted laterally, branchiostegal spine distinct; areola with three rows of punctations at narrowest point, margins parallel at mid-length; antennal scale (fig. 194) unevenly rounded mesially, widest at mid-length; chelae (fig. 195) punctate, fingers emarginate, slightly agape, double row of raised tubercles on mesial aspect of palm and movable finger, carpus with two sharp mesial spines, anterior spine largest; ischius of third pereiopods each with a hook.

Gonopods (figs. 191, 197) ending in two elongate processes, both processes gently curved caudad at tips to angle considerably less than 90 degrees with axis of shaft; lateral process (central projection) longer, corneous; mesial process noncorneous; both processes bladelike at tips, tips reach to base of second pereiopods with abdomen flexed.

Male form II: (figs. 192, 196).

Female: Annulus ventralis (fig. 198) with deep median sinus in anterior half; annulus divided by sinuous median fissure curving into deepest portion of sinus.

Color in life: Body green to dull rusty reddish-brown dorsally; chelae green, blue or bluish-green dorsally, with scattered bright yellow to orange tubercles especially on cutting edges of fingers and along margins; olive maculations often on palms and/or cephalothorax; eggs apparently black; freshly molted individuals light green.

Variations: This widely distributed species shows many local variations. Some of the more striking variations are constant for local populations, but many are entirely individual in character. For example, lots from Dallas, Douglas and Green counties, Missouri contain specimens with cephalothorax tending not to be depressed, and with rostrum tending to be wider than typical for the species. Lots 470 and 479 from Dallas and Polk counties, Missouri contain first form males that possess a slight swelling on the mesial process of the gonopods. Specimens in these lots have broad rostra with nearly parallel sides. Lots 493, 497 and 499 from the Shoal River and southern portion of the Spring River drainages in Jasper and Newton counties, Missouri have broad rostra, but specimens in lot 502 from Barton County, Missouri in the northern portion of the Spring River drainage have extremely narrow rostra. Sculpture of the annulus and degree of development of the lateral rostral spines varies from population to population.

Such population differences in *O. nais* are nearly as great as some specific differences between other species, but in this widely ranging form they may be attributed to partially interrupted gene flow from population to population. Such populations would be expected to be more distinct in mountainous regions than on less dissected terrain. Comparison of population differences in *O. nais* in Kansas and the Ozark region seems to bear out this contention. Williams and Leonard (1952:993) noted some population differences in *O. nais* in Kansas. The local populations do not appear to be worthy of subspecific designation because the same or quite similar differences occur repeatedly in widely scattered localities.

Ecological notes: Information on the ecology of *O. nais* has been summarized by Williams and Leonard (1952:993). The species apparently exists in a wide variety of ecological situations ranging from that of farm ponds to swiftly flowing streams. The species is not a truly burrowing species, but does construct burrows in banks of streams and ponds particularly in dry weather. The species has a preference for quiet streams or back water pools along streams.

Orconectes nais is associated with *Procambarus simulans, P. gracilis, Orconectes nana nana, O. nana macrus, O. ozarkae, O. punctimanus, O. neglectus neglectus, O. luteus, O. longidigitus, O. immunis, Cambarus hubbsi* and perhaps *Procambarus blandingii acutus* and *Orconectes palmeri longimanus* where these species occur within its range.

Specimens examined: Four hundred fifty-two as follows: ARKANSAS. *Carroll County:* Lot 657. Spider Creek and White River, $10\frac{3}{10}$ mi. NW Eureka Springs; *Izard County:* Lot 610. A small creek, 1 mi. W Violet Hill; Sharp County: Lot 708. Big Creek, ½ mi. S Ash Flat. *Stone County:* Lot 617. A small creek, $3\frac{9}{10}$ mi. SW Mountain View; Lot 619. Turkey Creek, $13\frac{9}{10}$ mi. SW Mountain View; *Van Buren County:* Lot 623. Pee Dee Creek, $7\frac{7}{10}$ mi. SW Shirley; Lot 792. South Fork Little Red River, $8\frac{7}{10}$ mi. SW Clinton. MISSOURI. *Barry County:* Lot 739. Roaring River, 100 yd. N Roaring River Hotel, Roaring River State Park; *Barton County;* Lot 502. ¼ mi. S Oakton; Lot 503. $1\frac{8}{10}$ mi. W Lamarr; *Bates County;* Lot 509. 3½ mi. S Rich Hill; Lot 511. $12\frac{4}{10}$ mi. SW Butler; *Camden County:* Lot 839. A cave, 2½ mi. S Camdenton; *Christian County:* Lot 455. Finley Creek at Ozark; *Cole County:* Lot 330. Moreau River, $5\frac{4}{10}$ mi. SW Jefferson City; *Cooper County:* Lot 328A. 1½ mi. SW Otterville; *Dallas County:* Lot 467. A small creek $8\frac{8}{10}$ mi. SSW Buffalo; Lot 470. Greasy Creek, 5 mi. SE Buffalo; Lot 472. Linley Creek, 4 mi. W Buffalo; *Douglas County:* Lot 446. A small creek, 6 mi. NW Ava; Lot 450. Little Beaver

Creek, 3½ mi. W Goodhope; *Greene County:* Lot 461. James River, 1 mi. S Galloway; Lot 463. Little Sac River, 10 mi. N Springfield; Lot 466. Pomme de Terre River, 15 3/10 mi. NNE Springfield; Lot 482. Little Dry Sac River, 1 2/10 mi. S Glidewell; Lot 485. A small creek, 11½ mi. W Springfield: Lot 486. Pickerel Creek, 10 7/10 mi. W Springfield; *Jackson County:* Lot 322A. Little Blue River, 8 mi. SE Kansas City; Lot 323A. 3 mi. E Lone Jack; *Jasper County;* Lot 485A. Center Creek, ½ mi. NE Sarcoxie; Lot 487A. Jenkins Creek, 7 7/10 mi. W Sarcoxie; Lot 491A. Spring River, ¼ mi. N Carthage; Lot 492A. A small creek, 1 4/10 mi. W Duenweg; Lot 499, 4 mi. N Diamond; *Johnson County:* Lot 324A. ½ mi. E Elm: Lot 325A. Black Water River, 7 mi. SE Pittsville; Lot 326A. 2 mi. E Knob Noster; *Lawrence County:* Lot 488. Billies Creek, ¼ mi. W Halltown; Lot 490. Turn Back Creek, 2 1/10 mi. W Halltown; Lot 493. Truitt Creek, 2 mi. N Mt. Vernon; Lot 496. Spring River, 2 mi. SW Mt. Vernon; Lot 481A. A small creek, 7 7/10 mi. WSW Mt. Vernon: *Miller County;* Lot 333. 2 mi. NE Tuscumbia; Lot 335. 1 7/10 mi. SW Tuscumbia; Lot 337. 1 6/10 mi. SE Tuscumbia; Lot 780. 7 mi. SE Tuscumbia on Mo. hy. no. 17; Lot 781. Tavern Creek, 3 2/10 mi. S Iberia on Mo. hy. no. 17; *Moniteau County:* Lot 329. 4 1/10 mi. E Tipton; *Newton County;* Lot 493A. Branch of Shoal Creek at Hornet; Lot 497A. Branch of Lost Creek, ½ mi. E Seneca; Lot 514. 1 8/10 mi. S Seneca; *Pettis County;* Lot 327A. A small creek, 6 3/10 mi. W Sedalia; *Polk County;* Lot 473. Hominy Creek, ½ mi. E Half Way; Lot 475. Pomme de Terre River, Burns; Lot 478. Piper Creek, 1 mi. E Bolivar; Lot 479. North Dry Sac River, 2 mi. S Brighton; *Vernon County:* Lot 504. Big Drywood Creek, 5 6/10 mi. W Nevada; Lot 507. Clear Creek, 12 mi. E Nevada; Lot 508. Douglas Branch, 6½ mi. N Nevada; OKLAHOMA. *Delaware County;* Lot 662 Flint Creek, 5 mi. E Kansas; Lot 764. 1 mi. W Flint; Lot 820. 5 mi. N Junction 59 and 10; *Ottawa County:* Lot 822. Ditch, 1½ mi. SW Miami.

Additional records: ARKANSAS. *Carroll County:* White River, Eureka Springs; *Washington County:* Prairie Grove and Fayetteville; MISSOURI. Osage River; St. Louis; *Jasper County; Newton County:* Neosho. OKLAHOMA. *Cherokee County:* Fourteen Mile Creek, McBride Switch; *Coal County:* Tributary of Boggy Creek at Olney; [*Ottawa County*]: Tributary Spring River, 1 mi. S Kansas state line; [*Pittsburg County*]: McAlester; *Rogers County:* Verdigris River; Verdigris River, 5 mi. W Claremore; *Wagoner County:* Wagoner.

Known range: The exact extent of the range of this species is not known. The species is distributed over all of Kansas, Missouri and Oklahoma (exclusive of the southeastern portions of the latter), in parts of northern Arkansas; it has been reported from scattered areas outside these states over the Great Plains west of the Mississippi River.

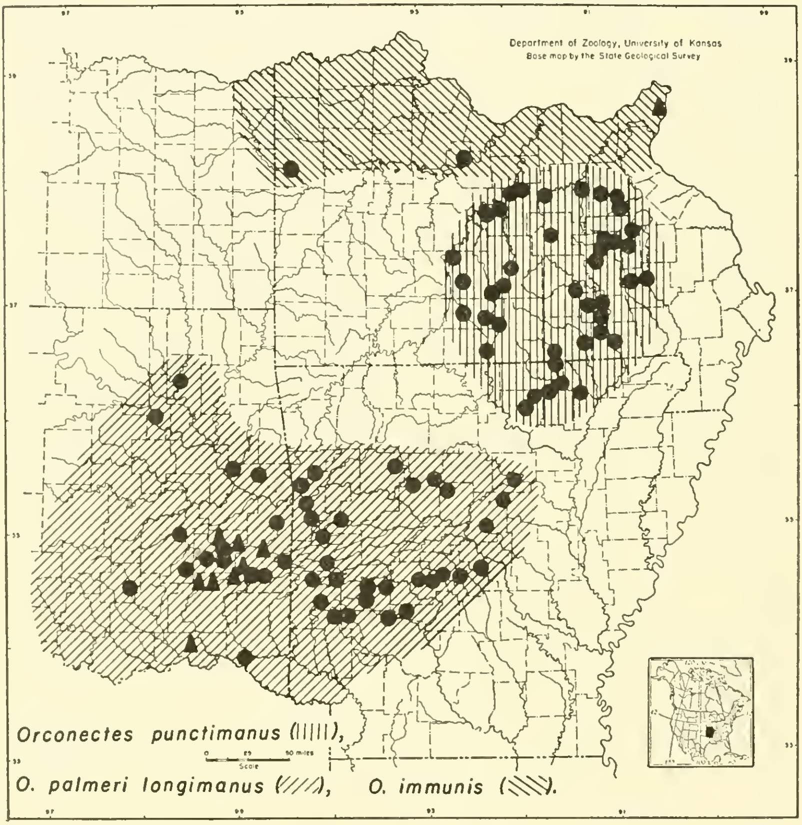

Department of Zoology, University of Kansas
Base map by the State Geological Survey
Orconectes punctimanus (||||),
0 25 50 miles
Scale
O. palmeri longimanus (////),
O. immunis (\\\\).

FIG. 200. Distribution of *Orconectes punctimanus, O. palmeri longimanus* and *O. immunis* in the Ozark Plateaus and Ouachita Provinces.

Orconectes immunis (Hagen)

Figs. 200-208

Cambarus immunis Hagen, Illus. Cat. Mus. Comp. Zool., No. 3, 1870, p. 71, pl. 1, figs. 101-102, pl. 3, fig. 160 pl. 8, fig. 6. (Type locality: Lawn Ridge, [Marshall County], Illinois.)

Cambarus signifer Herrick, 10th Ann. Rpt. Geol. Surv. Minnesota, 1882, p. 253.

Cambarus immunis spinirostris Faxon, Proc. Amer. Acad. Arts and Sci., Vol. 20, 1884, p. 146.

Faxonius immunis immunis Creaser, Occ. Pap. Mus. Zool., Univ. Michigan, No. 275, 1933, p. 13.
Faxonius immunis pedianus Creaser, *Ibid.*, p. 14.
Faxonius immunis pedianus Fleming, Jour. Tennessee Acad. Sci., Vol. 14, No. 3, 1939, p. 302.
Orconectes immunis immunis, Hobbs, Amer. Midl. Nat., Vol. 28, No. 2, 1942, p. 350. Hobbs and Marchand, Jour. Tennessee Acad. Sci., Vol. 18, No. 1, 1943, p. 24, pl. 2, figs. 4, 8, pl. 3, figs. 18, 25. Rhoades, Amer. Midl. Nat., Vol. 31, No. 1, 1944, p. 132.

Recognition characters: Male form I: Rostrum (fig. 203) longer than broad, reaching anteriorly to tips of antennal scales, excavated dorsally, lateral rostral spines, indistinct or absent; postorbital ridges each terminating anteriorly in a blunt spine; cephalothorax ovate; cephalic groove interrupted laterally, short sharp branchiostegal spines present; areola narrowest in anterior half of length, with one row of punctations at narrowest point; antennae shorter than body; antennal scale (fig. 208) unevenly rounded mesially, widest near mid-length, truncate at apex, terminal spine small; chelae (fig. 204) slender, punctate, tuberculate along mesial margin of palm and movable finger, large opposed tubercles in proximal half of opposed edges of fingers; carpus with one large sharp spine and several small spines mesially; anterior process of epistoma triangular, margins finely and irregularly toothed; ischius of third pereiopods each with a strongly pointed hook.

Gonopods (figs. 201, 206) terminating in two elongate processes, tips of processes bent at approximately 90 degree angle to axis of shaft, lateral process (central projection) corneous; mesial process noncorneous, excavated on cephalic surface; tips of gonopods reaching base of third pereiopods with abdomen flexed.

Male form II: (figs. 202, 205).

Female: Annulus ventralis (fig. 207) laterally elongate, deepest portion of sinus displaced to right or left of midsagittal plane, sculpture variable.

Color in life: Ground color olive green, first segment of abdomen may show light tinge of red dorsally; appendages with pinkish hue; chromatophores on dorsal side form irregularly shaped symmetrical pattern in freshly molted individuals; eggs of young females brownish red, eggs of old females darker.

Ecology and life history: The ecology and life history of *O. immunis* has been more thoroughly studied than that of any species of crayfish which occurs in the Ozark area. Tack (1941:422) studied this species where it occurs at Ithaca, New York. A review of Tack's work with added notes on the species where it occurs in

Kansas is contained in Williams and Leonard (1952:1001). This information can be summarized as follows:

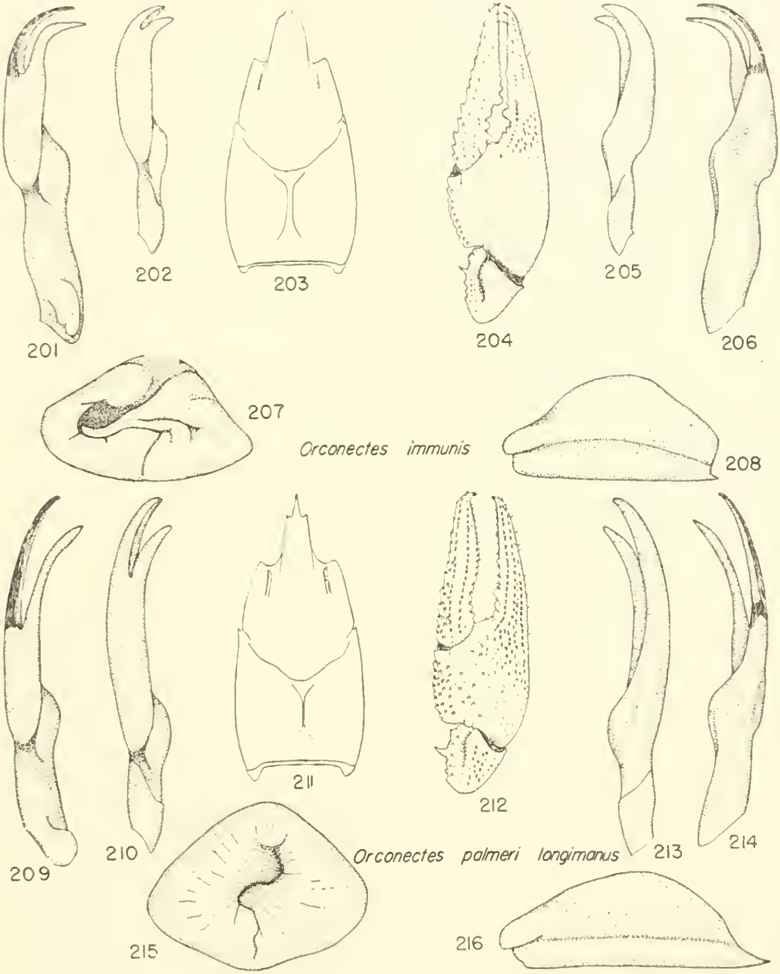
1. The species apparently prefers to live in roadside ditches, ponds and small sluggish mud-bottomed streams.
2. Burrows are usually constructed in the banks at the surface of the water.
3. More than one individual may occupy shallow burrows under overhanging turf at the surface of the water.
4. Burrows may be sealed with mud at times of low water.
5. The young are active both day and night during their first summer.
6. Adults are primarily nocturnal.
7. Adults may migrate overland at night, particularly when grass is wet with dew or rain.
8. Mating season at Ithaca, New York, extends from as early as June 16 to as late as October 12.
9. Mating frequency reaches its peak in late August.
10. Males or females may mate with more than one individual.
11. Eggs are laid chiefly in the months of October and November.
12. Females carry the eggs through the winter and the eggs hatch about mid-May.
13. Hatched young remain permanently attached to the females succeeding the first two molts.
14. The young are freed after the third molt.
15. Numerous molts occur during the first summer. A few members of the early spring brood may attain maturity at the end of the first summer.
16. A general spring molting for all individuals except those females carrying eggs occurs in the spring.
17. Death of a majority of the breeding males occurs at the end of the breeding season in the fall.
18. Death of a majority of the adult females occurs in the spring during and succeeding the spring molt after the young have been freed.

Orconectes immunis is associated with *O. nais,* and perhaps with *Procambarus simulans, P. gracilis, O. palmeri longimanus,* and *Cambarus diogenes* where these species occur within its range in the borders of the Ozark Plateaus and Ouachita Provinces.

Specimens examined: Thirteen in Ozark-Ouachita Provinces as follows: MISSOURI. *Bates County:* Lot. 510. 10½ mi. SW Butler; *Miller County:* Lot 332. 2 mi. NE Tuscumbia; OKLAHOMA. *Wag-*

oner County: 18 mi. E Tulsa (purchased from bait dealer); Paratypes, M.C.Z.

Additional records: MISSOURI. St. Louis; OKLAHOMA. *Okfuskee County:* Muddy Creek near Okemah.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Orconectes immunis
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Orconectes palmeri longimanus
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Orconectes immunis. Lot 265; 1 mi. S Lawrence, Douglas County, Kansas; 20 May 1947. Fig. 201, ♂ I gonopod, mesial view; Fig. 206, ♂ I gonopod, lateral view; Fig. 202, ♂ II gonopod, mesial view; Fig. 205, ♂ II gonopod, lateral view; Fig. 203, Carapace; Fig. 204, Chela and carpus; Fig. 207, Annulus ventralis; Fig. 208, Antennal scale. *Orconectes palmeri longimanus.* Lot 679; 9 mi. W Mena, Polk County, Arkansas; 2 Oct. 1948. Fig. 209, ♂ I gonopod, mesial view; Fig. 214, ♂ I gonopod, lateral view; Fig. 210, ♂ II gonopod, mesial view; Fig. 213, ♂ II gonopod, lateral view; Fig. 211, Carapace; Fig. 212, Chela and carpus; Fig. 215, Annulus ventralis; Fig. 216, Antennal scale.

Known range: The known range of this species is from Massachusetts to Wyoming and from Tennessee to Ontario.

Remarks: The systematic status of *Orconectes immunis* has been fully reviewed by Williams and Leonard (1952:1003). This species was formerly considered to be composed of an eastern and a western subspecies. However, the characters on which the subspecies were based (proportional length of anterior and posterior portion of the cephalothorax, and lateral rostral spines) are so variable in widely separated localities, and the proposed region of intergradation is so broad (Missouri, Illinois, Indiana) that such a designation seems untenable. The data indicate that this species presents an east-west cline ranging from the New England states to the Rocky Mountains. Specimens from the extremes of this cline are quite distinct, but a series of specimens from the intervening territory show a gradation in the variable characters.

Orconectes palmeri longimanus (Faxon)

Figs. 200; 209-216

Cambarus palmeri longimanus Faxon, Proc. U. S. Nat. Mus., Vol. 20, No. 1136, 1898, p. 655, pl. 64, figs. 1-6. (Type locality: Arthur City, Lamar County, Texas.)

Cambarus longimanus, Creaser, Pub. Univ. Oklahoma Biol. Surv., Vol. 5, No. 2, 1933, p. 38, figs. 4, 16, 26.

Orconectes palmeri longimanus, Hobbs, Amer. Midl. Nat. Vol. 28, No. 2, 1942, p. 350.

Recognition characters: Male form I: Rostrum (fig. 211) with sides nearly parallel, slightly divergent at base, acumen long, acute, lateral rostral spines well-developed, acute; postorbital ridges each terminating anteriorly in a well-developed acute spine; cephalothorax subcylindrical, depressed; cephalic groove nearly continuous laterally, branchiostegal spine well developed; areola obliterated at middle; antennae longer than body; antennal scale (fig. 216) evenly rounded mesially, widest at mid-length; chelae (fig. 212) long, heavy, palm and proximal two thirds of movable finger with conspicuous double row of raised ciliated tubercles, palm with squamous tubercles on mesiodorsal surface, fingers heavily punctate dorsally with punctations forming rows separated by ridges; carpus with squamous tubercles mesiodorsally, with prominent mesial spine and an anterior and posterior mesial tubercle; anterior process of epistoma subtriangular with anterior margin more or less rounded; ischius of third pair of pereiopods each with a hook.

Gonopods (figs. 209, 214) terminating in two elongate processes, both bent slightly caudad; lateral process (central projection) corneous, mesial process noncorneous, both processes thin, bladelike distally.

Male form II: (figs. 210, 213).

Female: Annulus ventralis (fig. 215) with margins inflated, slightly wrinkled, sinus in cephalic half of annulus sigmoid in shape; annulus divided by a longitudinal sinuous fissure curving into sigmoid sinus.

Variations: Orconectes palmeri longimanus shows individual variation in sculpture of the annulus ventralis, length of the chelae, width of the rostrum and shape and width of the antennal scale.

Knowledge concerning the exact status of *O. p. longimanus* and *O. p. palmeri* has been more or less inadequate for a number of years. Specimens of *O. p. longimanus* from the western portion of Arkansas and the eastern portion of Oklahoma do appear to be distinct when compared with *O. p. palmeri* specimens from the Mississippi Valley in northeastern Arkansas but these two forms apparently intergrade in central Arkansas. I have listed specimens in Lot 576 (Pulaski County, Arkansas) as *O. p. longimanus,* but these specimens share many characteristics with specimens of *O. p. palmeri* from Lonoke County, Arkansas and I consider them to be intergrades between these two subspecies. Lots 704 and 705 (Faulkner County, Arkansas) also contain specimens which probably are intergrades between the two subspecies.

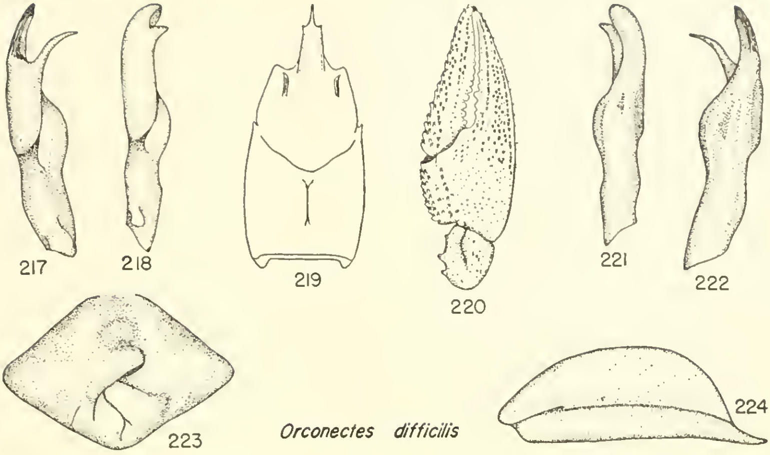
The Pulaski County specimens show intergradation in the shape of the chelae and especially in the sculpture of the annulus ventralis. Specimens from Faulkner County exhibit some evidence of intergradation in the sculpture of the annulus ventralis, but not so markedly as do the Pulaski County specimens.

This area in central Arkansas, and in fact all of eastern Arkansas and the Arkansas River Valley needs a thorough investigation in order to clarify our understanding of the faunal interrelationships between the Mississippi Valley, and the Ozark and Ouachita Mountains crayfishes.

Ecological notes: Orconectes palmeri longimanus is found in a wide range of habitats ranging from that of swiftly flowing rocky streams to that of slowly moving mud-bottomed streams.

Orconectes palmeri longimanus is associated with *Procambarus blandingii acutus, P. tenuis, P. simulans, Orconectes leptogonopodus, O. menae, O. meeki meeki,* and perhaps with *Procambarus vioscae,* where these species occur within its range.

Specimens examined: Four hundred as follows: Arkansas. *Clark County:* Lot 698. Caddo River, 2½ mi. NE Amity; *Cleburne County:* Lot 706. Sugar Loaf Creek at Heber Springs; Lot 707. Little Red River, 3 mi. N Heber Springs; *Conway County:* Lot 627. A small creek $1\frac{4}{10}$ mi. WNW Jerusalem; *Crawford County:* Lot 533. Tributary of Frog Bayou, $9\frac{3}{10}$ mi. SSW Mountainburg; Lot 534. Tributary of Arkansas River, $5\frac{7}{10}$ mi. SW Alma; *Faulkner County:* Lot 703. A small creek, 2 mi. N Hamlet; Lot 704. A small creek, 4 mi. N Mt. Vernon; Lot 705. E Fork Cadron Creek, $4\frac{6}{10}$ mi. N Mt. Vernon; *Garland County:* Lot 567. Glazypeau Creek, 5 mi. SW Mountain Valley; Lot 569. South Fork River, 5 mi. SE Mountain Valley; Lot 572. South Fork River, $8\frac{3}{10}$ mi. NE Hot Springs; *Hot Springs County:* Lot 701. A creek, 8 mi. E Bismarck; *Howard County:* Lot 687. Saline River, 3 mi. NW Athens; *Johnson County:* Lots 633 and 793. Little Piney Creek, 1½ mi. SE Mt. Levi; *Logan County:* Lot 674. Booneville Creek, E border of Booneville; *Montgomery County:* Lot 560. South Fork of Ouachita River at Mount Ida; Lot 565. A small creek, 1 mi. SE Joplin; Lot 691. Little Missouri River, Camp Albert Pike Rec. Area, 6 mi. NW Langley; Lot 694. Caddo River at Norman; *Pike County:* Lot 689. Little Missouri River, 4 mi. W Langley; *Polk County:* Lot 545. Tributary of Ouachita River at Mena; Lot 550. Tributary of Ouachita River, $4\frac{6}{10}$ mi. E Ink; Lot 553. Tributary of Ouachita River, $2\frac{1}{10}$ mi. E Cherry Hill; Lot 675. Mountain Fork River, 15 mi. WNW Mena; Lot 676. Small tributary of Mountain Fork River, 10 mi. WNW Mena; Lot 679. Rock Creek, 9 mi. W Mena; Lot 681. Twin Springs, SE Slope Whiskey Peak, 3 mi. WSW Hatton; Lot 682. Gilliam Springs on Cossatat River, approximately 5 mi. NW Hartley; Lot 685. Tributary of Cossatat River, 1½ mi. E Hartley; *Pope County:* Lot 628. A small creek, $9\frac{6}{10}$ mi. NW Moreland; Lot 630. Illinois Bayou, 1 mi. NW Dover; *Pulaski County:* Lot 576. Fourche Creek, 9 mi. SW Little Rock; *Saline County:* Lot 574. Big Creek, 3 mi. E Crows; Lot 575. A small creek, $8\frac{7}{10}$ mi. ESE Crows; *Scott County:* Lot 537. Kings Creek, $10\frac{7}{10}$ mi. N Waldron; Lot 538. Brushy Creek, $9\frac{3}{10}$ mi. N Waldron; Lot 539. Clear Creek, $7\frac{3}{10}$ mi. N Waldron; Lot 540. Ross Creek, $4\frac{2}{10}$ mi. SSE Waldron; Lot 541. Buffalo Creek, $9\frac{1}{10}$ mi. SE Waldron; Lot 542. Mill Creek, 4 mi. SSW Boles; *Sebastian County:* Lot 535. A small creek, 4 mi. SE Old Jenny Lind; Lot 536. Branch of James Fork, 8 mi. S Greenwood. Oklahoma. *Choctaw County:* Lot 827. Ft. Towson; *Latimer County:* Lot 806. Stream, 2 mi. S Yanush; *LeFlore County:* Lot 807. 3 mi. W Whitesboro; Lot 809.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Orconectes difficilis
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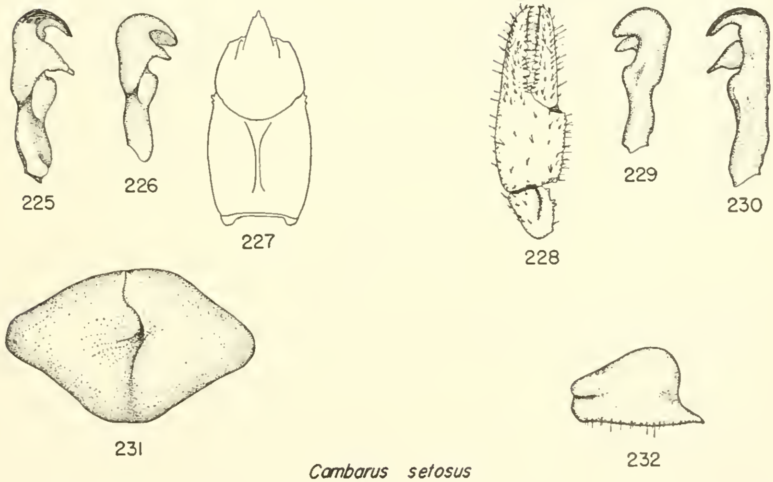
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Cambarus setosus
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Orconectes difficilis. Lot 796; 2½ mi. SE McAlester, Pittsburg County, Oklahoma; 24 Mar. 1951. Fig. 217, ♂ I gonopod, mesial view; Fig. 222, ♂ I gonopod, lateral view; Fig. 218, ♂ II gonopod, mesial view; Fig. 221, ♂ II gonopod, lateral view; Fig. 219, Carapace; Fig. 220, Chela and carpus; Fig. 223, Annulus ventralis; Fig. 224, Antennal scale. *Cambarus setosus.* Lot 483; Smallins Cave, $7\frac{4}{10}$ mi. SE Galloway, Christian County, Missouri; 26 Aug. 1948. Fig. 225, ♂ I gonopod, mesial view; Fig. 230, ♂ I gonopod, lateral view; Fig. 226, ♂ II gonopod, mesial view; Fig. 229, ♂ II gonopod, lateral view; Fig. 227, Carapace; Fig. 228, Chela and carpus; Fig. 231, Annulus ventralis; Fig. 232, Antennal scale.

Stream, 1 mi. NW Muse; Lot 812. 1 mi. E Page; Lot 813. Stream, 1 mi. SE Shady Point; *Pittsburg County:* Lot 802. Creek, 3 mi. NW Counts; *Sequoyah County:* Lot 760. Swimmers Creek, 10 mi. N

Gore; Lot 765. 3⁹⁄₁₀ mi. N Sallisaw on U. S. hy. no. 59; Lot 766. 1¹⁄₁₀ mi. W, 8⁷⁄₁₀ mi. N Sallisaw on U. S. hy. no. 59.

Additional records: Oklahoma. *[Atoka County]:* Limestone Gap, Choctaw Mountain [at Gap]; *Choctaw County:* Tributary of Kiamichi River, Goodland; *Latimar County:* Buffalo Creek, 5 mi. NW Tuskahoma; Tributary of Jackfork River, 6 mi. E Weathers; North Fork, Gaines Creek, 6 mi. S Wilburton; Brazil Creek, 3 mi. N Red Oak; Lake Wilson, 4 mi. NW Wilburton; Cunneo Tubby Creek, 2¼ mi. N Wilburton; Cunneo Tubby Creek, 4 mi. NE Wilburton; Pools along roadside, 4 mi. N Wilburton; Pond on college campus, Wilburton; Little Fourche Maline Creek, 1½ mi. E Wilburton; Tributary of Fourche Maline Creek, 1½ mi. E Wilburton; Bandy Creek, 1 mi. S Wilburton; *LeFlore County:* Rock Creek, 1 mi. SW Talihina; Stream, 4¾ mi. NE Wister; 5 mi. E Fanshawe; *McCurtain County:* Yanubbe Creek, 2 mi. N Broken Bow; *Pittsburg County:* North Fork, 4 mi. E Weathers; Pool near railroad, ½ mi. N Bache; *Pushmataha County:* Walnut Creek, Kainister [Kiamichi?]; Walnut Creek, 1 mi. SW Albion; *Rogers County:* Verdigris River.

Known range: The known range of this subspecies is confined to the localities listed above.

Orconectes difficilis (Faxon)

Figs. 217-224; 233

Cambarus difficilis Faxon, Proc. U. S. Nat. Mus., Vol. 20, No. 1136, 1898, p. 656, pl. 65, figs. 1-4. (Type locality: McAlester, Pittsburg County, Oklahoma.)

Orconectes difficilis, Hobbs, Amer. Midl. Nat. Vol. 28, No. 2, 1942, p. 350.

Recognition characters: Male form I: Rostrum (fig. 219) with sides nearly straight and converging anteriorly, dorsal excavation deep, acumen long, lateral rostral spines distinct; postorbital ridges each terminating in a prominent spine directed anterolaterally; cephalothorax subcylindrical, slightly depressed, cephalic groove interrupted laterally, branchiostegal spine well developed; areola completely obliterated in middle; antennae approximately as long as body; antennal scale (fig. 224) evenly rounded mesially, widest at mid-length; chelae (fig. 220) with palm inflated, fingers flattened, fingers heavily punctate with prominent ridges dorsally, immovable finger and palm emarginate laterally, palm and distal three-fourths of movable finger with double row of prominent tubercles mesially; carpus with three well-developed mesial spines and variable number of spiniform tubercles dorsomesially; anterior process of epistoma roughly bell-shaped; ischius of third pereiopods each with a hook.

Gonopods (figs. 217, 222) short, thick, terminating in two short processes, both curved caudad; lateral process (central projection) corneous, thick at base, thin and blade-like distally; mesial process noncorneous, thinner than central projection, curved caudad at nearly 90 degree angle to axis of shaft.

Male form II: (figs. 218, 221).

Female: Annulus ventralis (fig. 223) subrhomboid in outline, cephalic margin concave, lateral and caudal margins inflated; left or right lateral portion with tonguelike eminence projecting across midsagittal plane into recess in opposite side; central sinus shallow, nearly obliterated; annulus divided by a sinuous longitudinal fissure.

Color in life: Male form I: Ground color a uniform light olive-green with darker stripes at posterior edge of tergae; hands light olive dorsally with numerous dark olive maculations and stripe of dark olive on hand laterally; fingers blue distally, tipped with orange-red; spines and tubercles orange-red. Females with similar coloration; eggs light olive to dark olive.

Variation: The most noticeable variation is in the sculpture of the annulus ventralis of the females.

Ecological notes: This species lives under rocks, in streams, and in submerged burrows in streams.

Orconectes difficilis is associated with *Procambarus simulans, P. blandingii acutus* and perhaps with *P. tenuis* and *P. gracilis* where these species occur within its range.

Specimens examined: Nineteen as follows: OKLAHOMA. *Pittsburg County:* Lot 707. A small stream 2½ mi. SE McAlester; Lot 799. Brushy Creek, 8 mi. SW Hartshorne.

Additional records: ARKANSAS. *Washington County:* Prairie Grove. OKLAHOMA. *Latimer County:* Bandy Creek, 1 mi. S Wilburton; *Pittsburg County:* McAlester.

Known range: The known range of this species is confined to the localities listed above.

Remarks: The record of specimens from Arkansas should be checked again for verification. Recent collecting in Washington County, Arkansas, has not revealed the presence of this species, and it is questionable that the species ranges into this region of Arkansas.

As Faxon noted in his description of this species, the great similarity in general body form to *O. palmeri longimanus* is striking. The coloration of the two species is almost identical and the general shape of the body and hands is quite similar. The western Ouachita Mountains should be thoroughly searched to determine the exact extent of the ranges of these two closely related species.

Genus *Cambarus* Erichson

The genus *Cambarus* has been redefined by Hobbs (1942a:354) as follows: "First pleopod of first form male terminating in two distinct parts; both short and usually heavy and tapering to a point. Both terminal elements are bent caudad and usually at about a 90 degree angle to the main shaft of the appendage. The central projection is corneous, and the mesial process is usually softer and sometimes bulbiform. Hooks are present on the ischiopodites of only the third pereiopods of the male. Third maxillipeds of normal size with a row of teeth along the inner margin of the ischiopodite."

This genus has been subdivided into four sections, three of which (*hamulatus, extraneus, diogenes*) occur in the Ozarks Province.

Ortmann (1905:121) considered the center of distribution of the genus *Cambarus* to encompass the southern Appalachians and possibly the Ozark Plateaus. The *hamulatus* section which includes the blind species in the genus were considered by Ortmann to be the most primitive members of the genus. He based this contention on two observations; the species comprising this section are not closely related, and the distribution of the section is discontinuous. The *extraneus* section is a more closely related group, but here again the distribution is apparently discontinuous, with the Ozark species comprising an isolated unit in the section.

According to Ortmann the members of the *diogenes* section represent the most advanced members of the genus, exhibiting close relationships and continuous distribution. Our knowledge of the range limits of the members of this section is incomplete but this much is certain, the species *C. diogenes* and perhaps *C. fodiens* have adopted a burrowing mode of life and have so successfully exploited this habitat that their distribution is widespread. The former ranges from the Atlantic Coast to the Rocky Mountains, but *C. fodiens* occupies a more northern position in the central and upper Mississippi Valley and southern Canada.

Ortmann (1905:118) defined the *hamulatus* section as follows: "Carapace subcylindrical. Rostrum with or without marginal spines. Chelae long, subcylindrical. Areola rather long. Eyes rudimentary."

One species (*C. setosus*) belonging to this section occurs in the Ozark Plateaus Province. This species is confined to the Springfield Plateau region and has been collected from a number of caves in southwestern Missouri. In addition, the species has been reported to occur in wells in this region.

Ortmann (1931:96) defined the *extraneus* section as follows: "Carapace more or less ovate, depressed, with or without lateral spines. Rostrum with marginal spines. Chelae not very elongated, depressed, and rather broad, but a little more elongated than in the sections of *bartoni* and *diogenes*. Areola more or less wide, and of variable, moderate length. Eyes well developed." One species (*C. hubbsi*) belonging to this section occurs in the Ozark Province.

Ortmann (1931:146) defined the *diogenes* section as follows: "Carapace ovate, compressed, and without lateral spines. Rostrum

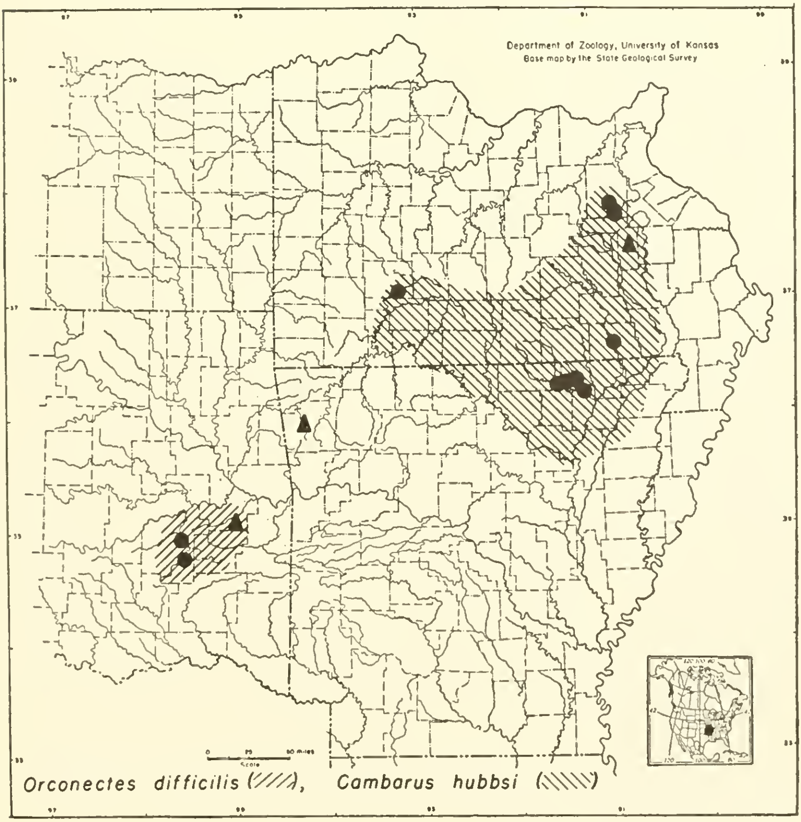

Department of Zoology, University of Kansas
Base map by the State Geological Survey
Scale
Orconectes difficilis (////), Cambarus hubbsi (\\\\)

FIG. 233. Distribution of *Orconectes difficilis* and *Cambarus hubbsi* in the Ozark Plateaus and Ouachita Provinces.

without marginal spines. Chelae short, ovate, broad, and depressed. Areola very narrow or obliterated (linear) in the middle, always distinctly longer than one third of the carapace." One species (*C. diogenes*) belonging to this section occurs in the Ozark Plateaus Province and another species (*C. fodiens*) occurs on the eastern border of this province.

KEY TO THE SPECIES OF THE GENUS CAMBARUS

1. Eyes rudimentary, body color white, antennal scale broadest near anterior border, *hamulatus* section . . . . *Cambarus setosus*, p. 902
1′. Eyes functional, body pigmented, antennal scale not as above . . 2
2. Rostrum with small lateral spines, *extraneus* section, *Cambarus hubbsi*, p. 904
2′. Rostrum lacking lateral spines, *diogenes* section, *Cambarus diogenes*, p. 908

Cambarus setosus Faxon

Figs. 225-233

Cambarus setosus Faxon, Bull. Mus. Comp. Zool., Vol. 17, 1889, p. 237, pl. 1, figs. 1-3, 7, pl. 2, fig. 1. (Type locality: Wilsons Cave, Jasper County, Missouri.)
Cambarus ayersii Steele, Pub. Univ. Cincinnati Bull. No. 10, Ser. 2, Vol. 2, 1902, p. 18, pl. 6, fig. 14.
Cambarus setosus, Hobbs, Amer. Midl. Nat., Vol. 28, No. 2, 1942, p. 354.

Recognition characters: Male form I: (fig. 227.) Eyes reduced, unpigmented; rostrum with sides converging toward short subtriangular acumen, nearly plane dorsally, lateral rostral spines reduced often asymmetrically placed; postorbital ridges each terminating anteriorly in a subacute spine; cephalothorax subcylindrical, greatly depressed, sparsely setose; cephalic groove continuous laterally, branchiostegal spines variable in number with one well-developed spine and approximately ten small tuberclelike spines; areola with sides nearly parallel, one row of punctations at narrowest point; antennae longer than body; antennal scale (fig. 232) broad, mesial lamellar portion thick, broadest near anterior margin; chelae (fig. 228) moderately slender, elongate, conspicuously setose on all surfaces, palm sparsely punctate dorsally, fingers with heavier punctations dorsally in rows separated by ridges, fingers not agape; carpus with conspicuous mesial, mesioventral and ventral spines, number and position highly variable; anterior process of epistoma laterally elongate, broadly joined to main plate of epistoma, anterior margin with prominent median projection and variable number of well-developed or nearly obliterated smaller projections; ischius of third pereiopods each with a hook.

Gonopods (figs. 225, 230) terminating in two greatly recurved processes; both processes recurved at angle of greater than 90 degrees with axis of shaft; lateral process (central projection) bladelike, corneous, mesial process noncorneous.

Male form II: (figs. 226, 229).

Female: Annulus ventralis (fig. 231) with all margins inflated except median cephalic portion; central sinus small, divided by a median sinuous longitudinal fissure.

Color in life: General ground color off-white, some individuals with slight reddish or rusty tinge on spines on carpus and merus, sides of rostrum, center of cephalic region, and bands on posterior margin of tergae; corneous spines on tips of chelae reddish; gill covers translucent, gills visible through gill covers and heart beating visible through carapace of medium sized individuals.

Variations: Cambarus setosus is highly variable in a number of its structural characteristics. The lateral rostral spines are highly variable in size and position and may or may not be present; the rostral shape varies; the areola width varies; the number and arrangement of spines on the anterior process of the epistoma is variable and the number of lateral spines on the gill covers is variable. All these variations are individual. This high degree of variability may have led Steele to name *C. ayersii* as a separate species, however topotypes of *C. setosus* show the characteristics of the type of *C. ayersii* as well as *C. setosus.* Creaser and Ortenburger (1933:41) suggested that these two forms were probably the same species and I consider them the same species. The type of *C. ayersii* is apparently an individual with regenerated chelae.

Ecological notes: Lots of *Cambarus setosus* in the University of Kansas Museum of Natural History collection have all been taken from caves in southwestern Missouri in which the water was clear and cold. Only one of these specimens has been taken in the twilight zone of a cave in the daytime and it was found under a rock. The rest of the collections have been made from pools in the region of total darkness in the daytime, or have been made near the entrance of a cave (Lot 794, Christian County) at night. This is in opposition to the observations recorded by Faxon (1889:227) who stated that *C. setosus* was active in wells and at the mouth of a cave in broad daylight.

Crayfishes in the dark regions of the caves did not seem to be affected by the light of lanterns. Individuals were found resting in open water on the solid rock or mud bottom, and rarely were taken from under cover. All of the specimens were easily picked up by hand, but they swam feebly when disturbed. This again is in opposition to observations recorded by Faxon (1889:227) who reported *C. setosus* as extremely difficult to capture even if the water was only slightly agitated.

Living specimens from a cave (Lot 718) were brought to the University of Kansas for observation. One of the specimens either died or was killed during the first night of captivity and was eaten by its companions. The remaining specimens were preserved in alcohol the next day. In warm water the crayfishes were more active than in the cold water in the caves, but they still did not exhibit the extreme activity recorded by Faxon (see above). *Cambarus setosus* can be maintained alive in captivity for long periods of time. I saw a specimen in shallow water in a large jar at Woods Hole Marine Biological Laboratory during the summer of 1949 which had been kept alive for several weeks. A bottle of water had been shipped in from Smallins Cave specifically for this purpose.

Cambarus setosus readily loses its appendages when placed in a jar of formalin. Specimens so treated had a tendency to grasp each other with their chelae and hold on tenaciously until dead. All movements were slow and deliberate.

Cambarus setosus is sometimes associated with *Orconectes neglectus neglectus* in the twilight zone of the caves in southwestern Missouri, but *C. setosus* occurs in this situation only at night.

Specimens examined: Thirty-three as follows: *Christian County:* Lots 483 and 794. Smallins Cave, 7⁴⁄₁₀ mi. SE Galloway; *Jasper County:* Lot 718. Cave on Cool Brook, 7 mi. E, ½ mi. N Carthage; Lot 750. Cave on Cool Brook, 8 mi. E Carthage, and Whisner Cave, 2 mi. NW Sarcoxie; M.C.Z. 4200, Wilsons Cave; Types, M.C.Z.; Paratypes, U.S.N.M.

Additional records: ARKANSAS. *[Lawrence County]:* U.S.N.M. 90323. Imboden [?]; MISSOURI. *[Jasper County]:* U.S.N.M. 62309. Sarcoxie. All literature records are from localities listed under "Specimens examined".

Known range: The known range of this species is confined to the localities listed above.

Cambarus hubbsi Creaser

Figs. 233; 235-245

Cambarus hubbsi Creaser, Occ. Pap. Mus. Zool., Univ. Michigan, No. 224, 1931, p. 4, figs. 7-12. (Type locality: Little Creek, tributary of St. Francis River, 1 mi. NE Chloride, Iron County, Missouri.)
Cambarus hubbsi, Hobbs, Amer. Midl. Nat. Vol. 28, No. 2, 1942, p. 354.

Recognition characters: Male form I: Rostrum (fig. 238) with sides converging to subtriangular acumen, tip of acumen and lateral rostral spines reduced to corneous rounded tubercles, tip of acumen occasionally abruptly curved dorsad; postorbital ridges each terminating in a low spine anteriorly; cephalothorax subcylindrical, strongly depressed; cephalic groove continuous laterally, branchiostegal spine absent, sides of areola subparallel, narrowest anterior to mid-length, with four rows of punctations at narrowest point; antennal scale (fig. 245) evenly rounded mesially, widest at mid-length, anterior spine deflected laterally; chelae (fig. 239, 244) heavily punctate, fingers heavily grooved with rows of punctations, fingers agape, palm with single row of low tubercles mesially; carpus heavily punctate, with single strong mesial spine; anterior process of epistoma broad, broadly convex anteriorly; ischius of third pair of pereiopods each with a hook.

Gonopods (figs. 235, 242) ending in two processes curved caudad at less than 90 degree angle with axis of shaft; lateral process (central projection) corneous, thin, bladelike; mesial process noncorneous, bulbiform with slender tip.

Male form II: (figs. 236, 237, 240, 241).

Female: Annulus ventralis (fig. 243) markedly asymmetrical, with inflated lateral margin on either right or left side, side opposite inflation prominent but wrinkled as if shrunken, with tonguelike projection from shrunken side fitting into deepest portion of sinus; annulus divided by sinuous fissure.

Color in life: Large male from Lot 594 (Lawrence County, Arkansas) with ground color fuscus, indefinite mottling dorsally on hand between fingers, around rostrum, rear of cephalic portion near areola and on carpus and merus dorsally; narrow black saddle over posterior edge of cephalothorax with slight overlap on first abdominal segment near middorsal line; dirty yellow ventrally.

Specimens in Lot 602 (Sharp County, Arkansas) with ground color muddy dark green to light fuscus.

Specimens in Lot 360 (Washington County, Missouri) tan with numerous small dark maculations dorsally.

Variations: Cambarus hubbsi is a species which shows rather marked geographic variations. Form I male specimens from the Big River drainage in Missouri have longer narrower chelae and rostra, and form II males have longer, more recurved processes on the gonopods than specimens from the White River drainage in Missouri. Specimens from the Spring River drainage in Arkansas have inflated chelae, with short gaping fingers, broader rostra, and gonopods with blunter less recurved tips than specimens from the Big River drainage in Missouri. Examples from the White River drainage have chelae which seem to be intermediate in shape between those occurring in the Big River drainage in Missouri and those in the Spring River drainage in Arkansas, but have gonopods and rostra like the Spring River specimens from Arkansas. These differences suggest a constancy in variation which may be indicative of subspeciation within this species, but in my opinion material at hand is too scattered and scanty to warrant such designation at present.

Ecological notes: This species has been collected from under large rocks or boulders seated in sand or fine gravel. In such situations the collections were made in a region of moderate current

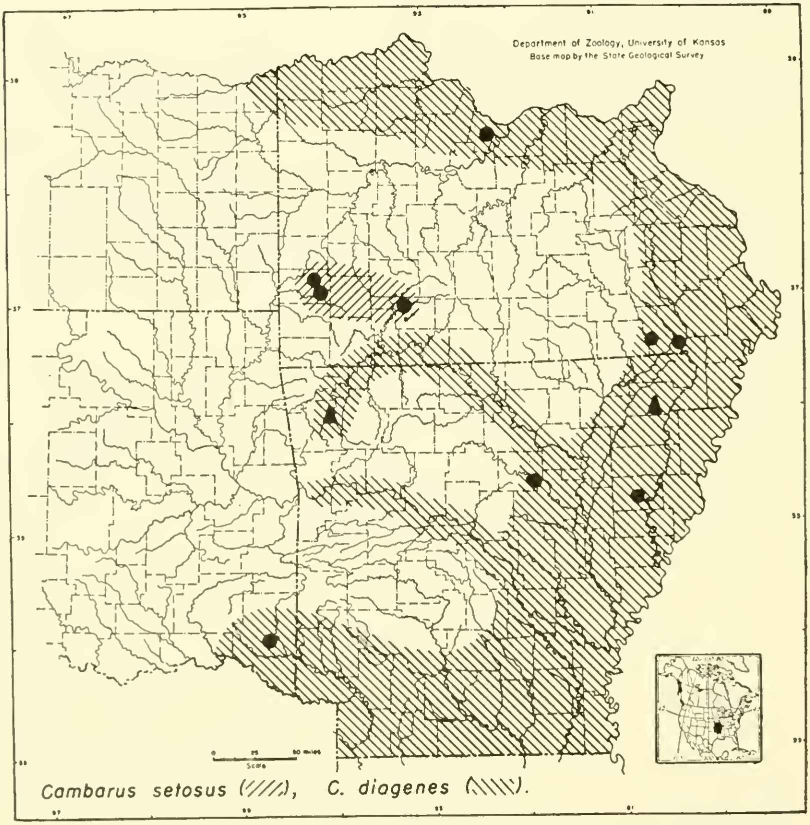
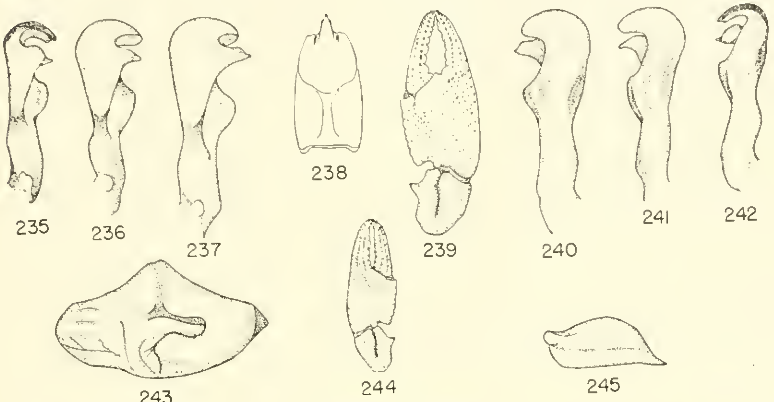
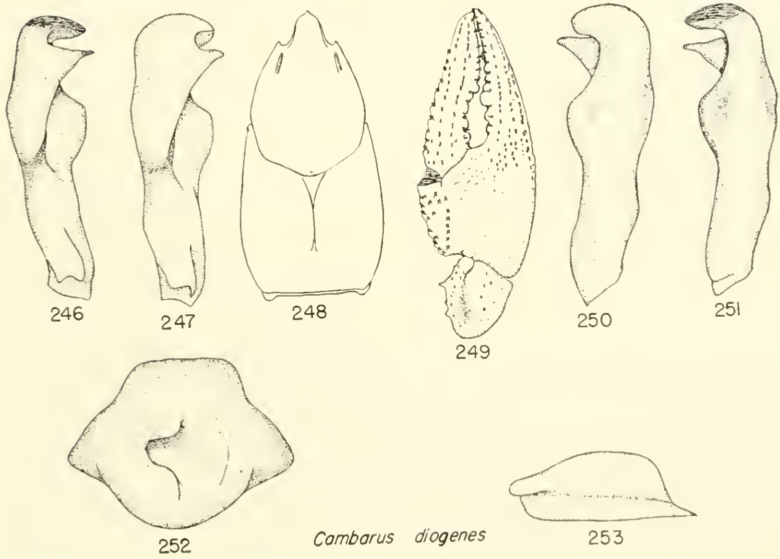

Department of Zoology, University of Kansas
Base map by the State Geological Survey
0 25 50 miles
Scale
Cambarus setosus (////), C. diagenes (\\\\).

FIG. 234. Distribution of *Cambarus setosus* and *C. diogenes* in the Ozark Plateaus and Ouachita Provinces.

from the water line near shore to depths of 1 to 2 feet. No burrows under the rocks were evident. Some collections were made under boulders in shallow quiet water, but Lot 602 was taken from solution holes in limestone in fast water in midstream on the Spring



Cambarus hubbsi



Cambarus diogenes

Cambarus hubbsi. Lot 416; Current River, Doniphan, Ripley County, Missouri; 21 Aug. 1948. Fig. 235, ♂ I gonopod, mesial view; Fig. 242, ♂ I gonopod, lateral view; Figs. 236, 237 ♂ II gonopod, mesial view; Figs. 240, 241, ♂ II gonopod, lateral view; Fig. 238, Carapace; Figs. 239, 244, Chela and carpus; Fig. 243, Annulus ventralis; Fig. 245, Antennal scale. *Cambarus diogenes.* Lot 283; ½ mi. S Muscotah, Atchison County, Kansas; 12 Oct. 1947. Fig. 246, ♂ I gonopod, mesial view; Fig. 251, ♂ I gonopod, lateral view; Fig. 247, ♂ II gonopod, mesial view; Fig. 250, ♂ II gonopod, lateral view; Fig. 248, Carapace; Fig. 249, Chela and carpus; Fig. 252, Annulus ventralis; Fig. 253, Antennal scale.

River in Sharp County, Arkansas. The largest specimens collected at this locality were taken from such holes in the lee of a small island in midstream.

Cambarus hubbsi is associated with *Procambarus blandingii acutus, Orconectes harrisonii, O. eupunctus, O. marchandi, O. punctimanus, O. ozarkae, O. neglectus neglectus, O. luteus, O. medius, O. longidigitus, O. nais* and perhaps with *O. quadruncus, O. peruncus,* and *O. neglectus chaenodactylus* where these species occur within its range.

Specimens examined: Sixty-one as follows: Arkansas. *Lawrence County:* Lot 594. Spring River, ½ mi. SSE Ravenden; *Sharp County:* Lot 595. Martin Creek, 2⁹⁄₁₀ mi. NE Williford; Lot 597. Sugar Creek, 6⁹⁄₁₀ mi. NW Williford; Lot 602 Spring River at Hardy. Missouri. *Greene County:* Lot 459 and M53267. James River, 1 mi. S Galloway; *Iron County:* M53265. Little Creek, 1 mi. NE Chloride; M53266, Ruble Spring Branch, 1 mi. S Chloride; *Oregon County:* Lot 421. Eleven Point River at Riverton; *Ripley County:* Lot 416. Current River at Doniphan; *Washington County:* Lot 360. Big River, 8⁹⁄₁₀ mi. S Potosi; Lot 368. Cedar Creek, 1½ mi. SE Caledonia; Paratypes in USNM.

Additional records: Missouri. *[Oregon county]:* U.S.N.M. 75584. Greer Springs, Greer. Records from the literature are confined to part of the localities listed above.

Known range: The known range of this species is confined to the localities listed above.

Cambarus diogenes Girard

Figs. 234; 246-253

Cambarus diogenes Girard, Proc. Acad. Nat. Sci. Philadelphia, Vol. 6, 1852, p. 88. (Type locality: near Washington, D. C.)
Cambarus nebrascensis Girard, *Ibid.*, p. 91.
Cambarus obesus Hagen, Illus. Cat. Mus. Comp. Zool., Harvard Coll., No. 3, 1870, p. 81.
Cambarus diogenes, Hobbs, Amer. Midl. Nat. Vol. 28, No. 2, 1942, p. 354.

Recognition characters: Male form I: Rostrum (fig. 248) subtriangular, depressed, longer than broad, without lateral spines; postorbital ridges with or without small anterior tubercle; cephalothorax robust, laterally compressed, cephalic groove deeply cleft, continuous laterally, branchiostegal spines absent; areola obliterated at least in middle; antennae longer than cephalothorax; antennal scale (fig. 253) roughly rectangular in outline, lateral spine prominent; chelae (fig. 249) heavy, punctate, with rows of deep punctations on fingers, movable finger and palm tuberculate mesially; carpus with one distinct and several indistinct spines mesially and one moderately produced ventral spine; anterior process of epistoma subtriangular, margin smooth; ischius of third pereiopods each with a strong hook.

Gonopods (figs. 246, 251) stout, terminating in two short processes bent at approximately 90 degree angle to axis of shaft; lateral process (central projection) corneous, thin, bladelike; mesial process noncorneous with "awl-like" tip; tips of gonopods reaching base of third pereiopods with abdomen flexed.

Male form II: (figs. 247, 250).

Female: Annulus ventralis (fig. 252) roughly quadrangular in outline, deepest portion of sinus displaced either to right or left of midsagittal plane, sculpture variable.

Ecological notes: Observations on the ecology of *C. diogenes* have been contributed by numerous authors. These observations have been summarized by Williams and Leonard (1952:1007), and may be briefly stated as follows:

1. *Cambarus diogenes* is a burrowing species which prefers to construct burrows in areas which are permanently wet or marshy.
2. Specimens have been collected from marshes, stream banks and ponds, but have been taken from open water only on rare occasions.
3. The burrows are often complex being composed of a number of channels and chambers. The burrows may be more than 12 feet deep.
4. Mating pairs have been observed in March, April, May and October.
5. Females in berry have been observed in January, April, and midsummer, and females with young have been observed in June.

Cambarus diogenes has an extremely broad range and is probably associated in some degree with all of the species of crayfishes occurring in the central part of the United States. Definite associations that I have observed are with (or near) *Procambarus gracilis, Orconectes luteus, O. nais,* and *O. immunis.*

Specimens examined: Thirty-nine as follows: ARKANSAS. *Cleburne County:* Lot 581. Little Red River, 1 mi. N Pangburn; *Cross County:* Lot 683. A small creek, 4⁷⁄₁₀ mi. ENE Wynne; MISSOURI. *Cole County:* Lot 331. Moreau River, 5¹⁄₁₀ mi. SW Jefferson City; *Butler County:* Lot 405. Drainage Canal, 2 mi. NW Qulin; Lot 407. Drainage Canal, 3 mi. NW Qulin; Lot 411. A small creek, 17 mi. E

Doniphan on Mo. hy. no. 14. OKLAHOMA. *McCurtain County:* O26A. Yannube Creek, 2 mi. N Broken Bow.

Additional records: ARKANSAS. U.S.N.M. 22381. St. Francis River; *Greene County:* Paragould; [*Lawrence County*]: U.S.N.M. 62305-62308. Imboden; *Washington County:* Fayetteville. MISSOURI. Osage River.

Known range: This species ranges from Alabama to Michigan and the Atlantic Coast to the Rocky Mountains in Colorado and Wyoming.

REDESCRIPTION OF SOME CAVES IN MISSOURI

Brief descriptions of some caves in southwestern Missouri are given in the following paragraphs. Information concerning certain of these caves has become buried in the literature, and in some instances names of the caves have changed. Some of these caves have been altered since the original descriptions were made.

Redescription of Wilsons Cave: This cave is on the north side of Center Creek Valley approximately 2 mi. NW Sarcoxie, Jasper County, Missouri. The locality may be stated more exactly as approximately ½ mile west of a bridge on a north-south road and approximately 100 yards west of a farm building on the old Wilson farm. The cave is now known as Whisner's Cave and is on property owned by Mr. V. V. Whisner.

The following description is based on field notes made by Dr. A. B. Leonard, 12 October, 1948. The cave has an entrance approximately 20 feet wide and seven or eight feet high. Approximately 30 feet from the entrance it narrows suddenly to a very narrow passage with a low ceiling through which a brook enters the northwest corner of the outer room. This room has been drained for stock water and is well filled with mud. No animals were found at the time of this visit; however Mr. Whisner said that his tenant, who lives on the farm, gets white blind fish and blind crayfish from his well in the spring of the year.

Cave on Cool Brook, 7 mi. E, ½ mi. N Carthage, Jasper County, Missouri: The following description is paraphrased from field notes of Dr. A. B. Leonard, 13 October, 1948. The cave is about 300 yards up Cool Brook from the road which this stream crosses. The brook is dammed about halfway between the road and the cave. Some summer cottages and a large stone fireplace and chimney (remnant of a burned house) stand near the dam.

The cave entrance has been partly dammed to hold water for domestic use. The opening is approximately eight feet wide and four feet high. The cave is approximately 20 feet wide inside at the mouth, and is roofed with an arch of solid stone approximately five and one-half feet high. Approximately 100 feet back the cave widens into a large room formed by the convergence of at least three water courses and at this place the ceiling descends suddenly. There are several levels of water courses at this point, the upper ones usually dry. When the upper courses are flowing, the cave cannot be entered. The water is clear and cold.

Sequiota Cave: This cave was formerly called Fishers Cave and was mentioned by Steele (1902:18) as the type locality of *Cambarus ayersii.* Investigation revealed that this cave is now called Sequiota Cave and is located in the Sequiota State Fish Hatchery in Galloway, Greene County, Missouri. We were not able to enter the cave at the time of our visit. A caretaker told us that entrance to the cave must be made by boat for the first 1600 feet. (The regular boat was waterlogged at that time.) This man also told us that blind crayfishes occur in the cave.

Smallins Cave: Smallins Cave is a large cave formed by solution of limestone. The cave is composed of a single large channel with no visible side channels. The opening at the entrance is approximately 50 feet high and 125 to 150 feet wide. The cave gradually diminishes in height, approaching a fairly uniform height of five to seven feet and a width of approximately 30 feet at ¼ mile from the entrance. At an estimated ½ mile from the entrance, the cave is three or four feet high with the roof progressively lower beyond this point. A stream flows through the cave. Many pools in this stream are four to five feet deep. Leaves are strewn along the stream course in the cave, indicating a surface source for the stream, and leaves sticking to the roof of the cave indicate that water must reach an additional depth of four to five feet when the stream is in flood.

EXTRALIMITAL SPECIES

A number of species have been reported from the Mississippi Embayment and Gulf Coastal Plain which may occur sporadically along the southeastern border of the Ozark and Ouachita Provinces. These species have not been illustrated or discussed in this paper because they properly belong to the Mississippi Valley or Gulf Coastal fauna.

Steele (1902:8) reported *Procambarus hayi* (Faxon) from the James River in Missouri, but this record has not been verified. *Pro-*

cambarus hayi is a form which ranges over the lower Mississippi Valley. *Procambarus clarkii* (Girard) occurs in eastern Arkansas.

Procambarus vioscae Penn has been collected from one locality in the southeastern Ouachitas (Lot 702) in a creek 8 mi. E Bismarck, Hot Springs County, Arkansas.

Cambarellus shufeldti (Faxon) has been collected in eastern Arkansas (Lot 585) in a slough 14⁴⁄₁₀ mi. W Augusta in White County.

Orconectes palmeri palmeri (Faxon) occurs in eastern Arkansas and in southeastern Missouri. *Orconectes lancifer* (Faxon) has been reported from northeastern Arkansas. Creaser and Ortenburger (1933:40) reported *Orconectes clypeatus* (Hay) from east-central Oklahoma, but this record has not been verified. This species ranges over the lower Mississippi Valley.

Hobbs (1948:230) reported *Cambarus fodiens* (Cottle) from northeastern Arkansas.

FAUNAL CONSIDERATIONS

A number of faunal considerations have been offered in the foregoing documented discussion under separate generic, sectional and group divisions. These considerations can now be consolidated.

The genus *Procambarus* presumably had a region in the southern Appalachians and the Gulf Coastal Plain as its primary center of distribution. From this region different members of the genus have dispersed in all directions. The *barbatus* section has members which are widespread in the northern Mississippi Valley and in southwestern United States. Species belonging to this section (*P. simulans, P. gracilis*) approach the Ozark-Ouachita Provinces on the north, west and southwest. The *blandingii* section is essentially a Gulf Coastal assemblage that has members (*P. blandingii acutus*) which invade the southeastern and southern approaches to the Ozark-Ouachita Provinces. The section has one member (*P. tenuis*) which is endemic to the central and western portions of the Ouachita Province.

The genus *Orconectes* presumably had its center of distribution in the central United States in the Mississippi Valley. This genus has diversified into four sectional assemblanges three of which (*limosus, propinquus, virilis*) have members which occur in the Ozark-Ouachita Provinces. Of these, the *limosus* section is considered to be the most primitive. It is characterized by a discontinuous distribution with members on the Atlantic Coastal Plain, in the Ohio Valley, and in the Ozark Plateaus Province (*Orconectes harrisonii*).

The *propinquus* section also has a discontinuous distribution, in the central-eastern and northeastern Mississippi Valley, and in the west in the Ozark-Ouachita Provinces. This section has diversified into definite groups, two of which (*hylas, rusticus*) occur in the physiographic region under consideration in this paper. Of these two groups, the *hylas* group is endemic to the region and has undergone a remarkable diversification. This diversification is apparently centered around four regions of endemism: (1.) the St. Francois Mountains of eastern Missouri (*O. peruncus, O. quadruncus, O. hylas*); (2.) the Eleven Point and Spring Rivers in southeastern Missouri and northeastern Arkansas (*O. eupunctus, O. marchandi*); (3.) the four-state region of Arkansas, Kansas, Missouri and Oklahoma (*O. nana nana, O. nana macrus*); (4.) the central and eastern portion of the Ouachita Mountains (*O. leptogonopodus, O. menae*). The distribution of the group as a whole is confined most exclusively to the southern and western drainages of the Ozark Plateaus Province and to the central and eastern Ouachita Province. This distribution lends credence to the contention that the Arkansas River at one time was much less a barrier to these species than it is at present, thus allowing members of the *hylas* group to invade the Ouachita Mountains from the north.

The great diversification of the *hylas* group in the streams of the Ozark Plateaus and Ouachita Provinces has a parallel in speciation in the genus *Cambarus* where its members occur in the southern Appalachians (Ortmann, 1905:129). This group of cambarids is typically a mountain stream group occurring in the uppermost headwaters of the drainage. However unlike the *hylas* group, this assemblage of species has evolved forms such as *C. diogenes* which have successfully invaded the lowlands, and perhaps due to fossorial habits have been able to disperse over central United States, the Gulf Coastal Plain and the Atlantic Coastal Plain.

The *rusticus* group is largely confined to the Ozark Plateaus Province where it occurs west of the Mississippi River and is represented by only three species, one of which shows subspecific differentiation (*O. medius, O. luteus, O. neglectus neglectus, O. n. chaenodactylus*). Within the Ozarks the group is characterized for the most part by widely ranging species and is distinctive in regard to one subspecies, *Orconectes neglectus neglectus,* which has a discontinuous distribution in central Kansas and was formerly reported in northeastern Colorado.

The *virilis* section is widely distributed over the physiographic region under consideration and it also has diversified into groups, two of which (*virilis, palmeri*) occur here. The *virilis* group is confined to the Ozarks portion of this region with two full species (*O. meeki* subspecies, *O. longidigitus*) which are endemic and two species (*O. nais, O. immunis*) which may be considered as invaders from the northern plains. The *palmeri* group is most characteristic of the Ouachitas and southern Ozarks (Boston Mountains). Members of the group which occupy this area (*O. palmeri longimanus, O. difficilis*) have definite affinities with species living in the Mississippi Embayment.

The genus *Cambarus* has been subdivided into four sections, three of which (*hamulatus, extraneus, diogenes*) occur in the Ozark-Ouachita Provinces. Each of these sections possesses one member species which lives in this region. The first two sections probably represent remnants of a continuous dispersal of those sections to the east in former times. At present the species belonging to these sections (*C. setosus, C. hubbsi*) are endemic to this region. The last section (*C. diogenes*) is apparently a recent invader of the region from a center of dispersal in the southern Appalachians.

ECOLOGICAL CONSIDERATIONS

Ecological parallels have evolved in the three genera under consideration in this study. These three general types can be described as follows:

1. Primarily burrowing types. Burrowing types are exhibited by all of the genera under consideration, but primarily burrowing types belong only to the procambarids and cambarids. An example of each would be *Procambarus gracilis* and *Cambarus diogenes.*

2. Secondary burrowers which live in lenitic or lotic situations. This group includes the great majority of this provincial fauna. Such species customarily live under rocks, or in shallow burrows under rocks, or in shallow burrows at the water's edge. These species burrow under rocks when streams go dry in late summer.

3. A third category, which would be called secondary burrowers by some, I have called "rock crawlers." These species are all relatively small in size and all of them have developed a preference for living under rocks or among the gravel and cobbles near shoals. Some of these species live under rocks which are well seated in mud, sand, or gravel. Some of the species are found in hillside seeps

which must surely go dry at the surface during most of the year. "Rock crawlers" are represented in the procambarids, orconectids and cambarids. With one exception (*Procambarus tenuis*) these species have depressed bodies, and large, powerful, rounded chelae. They give the impression of being ideally adapted to crawling under rocks. This adaptation probably reaches its acme in *Cambarus hubbsi* which has the most depressed body form and is the most powerfully built of any of the rock crawlers. All of these species have a coloration which is dull and ground-colored.

CONCLUSIONS

1. Ortmann's contention that isolation and discontinuity in distribution are indicative of primitiveness is emphasized by the distribution of the Ozarkian and Ouachitan crayfishes.

2. These mountain provinces are characterized primarily by an endemic crayfish fauna, and are invaded incompletely by widely ranging species from surrounding areas.

3. Four centers are present in these provinces which contain more than one endemic species of crayfish.

a. The St. Francois Mountains in eastern Missouri.

b. The Spring and Eleven Point Rivers in southeastern Missouri and northeastern Arkansas.

c. The central Ouachita Mountains near and on the Arkansas-Oklahoma state line.

d. The four-state area of Arkansas, Kansas, Missouri, and Oklahoma.

4. The fauna of these regions shows definite relationships with the fauna east of the Mississippi Embayment. These two regions were at one time probably faunistically continuous.

5. The *hylas* group has diversified strikingly within both of the provinces under consideration.

a. The group has successfully invaded all of the major drainages except the western Osage River drainage.

b. The *hylas* group presents a remarkably complete phylogenetic assemblage with *eupunctus*, presumably the most primitive member, showing definite affinities to the *propinquus* assemblage of the Ohio Valley.

c. This group of species stems from a line composed of *eupunctus, marchandi, quadruncus,* and *peruncus,* then dichotomizes into a series including *hylas, nana nana, nana macrus,* and *leptogonopodus* on the one hand, and a series composed of *punctimanus* and *ozarkae* on the other hand. The aberrant species *menae* is difficult to place but is probably most closely related to the *punctimanus* branch.

6. The Arkansas River, presumably a barrier at present, may have been considerably less a barrier in Pleistocene times allowing the *hylas* group to invade the Ouachita Province.

7. The three genera under consideration have developed ecological equivalents.

8. The distribution of some of these crayfishes follows one particular drainage.

9. Some species have successfully crossed headwater divides. Whether this is due to stream piracy or to the wandering tendencies of crayfishes is a moot point.

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A New Subgenus and Six New Species of Chigger Mites (Genus Trombicula) from the Central United States[1, 2]

By

RICHARD B. LOOMIS

ABSTRACT: The following larval chigger mites of the genus *Trombicula* are described from the central United States. A new subgenus *Euschöngastoides* is proposed with *Trombicula hoplai* sp. nov., as the type and only species. This chigger mite is known from south-central Kansas to northern Texas and westward to western Colorado. The other new species are *Trombicula* (*Leptotrombidium*) *twentei*, known from south-central Kansas; *T. crossleyi* from south-central Kansas and south-central Oklahoma; *T. fitchi* from south-central and eastern Kansas, southeastern Nebraska and central Illinois; the closely related *T. kardosi* taken in eastern Kansas and southwestern Utah; and *T. arenicola* from southwestern Kansas west to western Utah and north to Alberta, Canada.

INTRODUCTION

A study of the larval chigger mites from Kansas and other central states has revealed six species belonging to the genus *Trombicula*, which seem to be new and are described below. One of the new species is considered significantly different from other described species and subgenera of *Trombicula* and is placed in a new subgenus.

I wish to express my appreciation to Mr. Louis J. Lipovsky for generously allowing access to his notes and sketches of *Trombicula fitchi* sp. nov. and *T. hoplai* sp. nov. Sincere thanks are extended to Dr. James M. Brennan of the Rocky Mountain Laboratory, U. S. Public Health Service, for examining several of the species and for the loan of specimens of *T. fitchi* and *T. arenicola* sp. nov. (listed below as RML). Dr. Brennan graciously sent these species which

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[1] The studies upon which this paper is based were conducted under a contract, N6 ori 220 Task Order 2, between the University of Kansas and the Office of Naval Research.

[2] Contribution No. 872 of the Department of Entomology, University of Kansas.

he was prepared to describe. I am grateful to the following persons for their help in assembling these larval chigger mites while at the University of Kansas; Mr. D. A. Crossley, Jr., Mr. Robert E. Elbel, Mr. Robert B. Finley, Jr., Dr. Henry S. Fitch, Mr. J. Knox Jones, Jr., Mr. Ervin H. Kardos, Mr. Louis J. Lipovsky, and Mr. Keith A. Wolfenbarger. Mr. David T. Clark of the University of Illinois, and Dr. Cluff E. Hopla of the University of Oklahoma also aided in collecting larval chiggers, for which I express my appreciation. The writer also wishes to thank Mr. Crossley, Dr. Fitch and Dr. Charles D. Michener of the University of Kansas for carefully reading the manuscript.

DESCRIPTION OF SPECIES

The terminology used throughout the paper is that of Wharton, *et al.* (1951). All of the measurements are in microns. Each description is based upon the holotype, with differences among the paratypes indicated in parentheses. All of the larvae were studied under a phase contrast microscope, with the specimens mounted on slides in polyvinyl alcohol medium (see Lipovsky, 1953). Drawings were made from specimens in the type series, with the aid of a camera lucida. Unless otherwise indicated, the specimens are in the Snow Entomological Museum, University of Kansas, with the slide numbers preceded by the initials KU.

Trombicula crossleyi * sp. nov.

Figs. 1-3

Types.—Larvae: Holotype, slide KU 3075, and 24 paratypes, KU 3069-74 and 3076-93, Snow Entomological Museum, University of Kansas, from 10½ miles west of Hardtner, Barber County, Kansas, taken from four red-headed woodpeckers, *Melanerpes erythrocephalus* (Linnaeus), field number RL520726-9, shot on July 26, 1952, by R. B. Loomis and D. A. Crossley, Jr.

Diagnosis.—Larva similar to *Trombicula trisetica* Loomis and Crossley, 1953, in having a small elongate body; palpal claw bifurcate with axial prong internal (and ventral); one masitarsala III, three pairs of sternal setae; eight dorsal setae in the first posthumeral row; and in having similar nude setae on the legs. *Trombicula crossleyi* differs from *T. trisetica* in having a scutum smaller with more distinctly protruding posterolateral corners, sensillae shorter with more numerous branches, galeal seta usually with a single branch, and in having the coxae III with five or more setae on at least one coxa, four to six setae on the other.

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* Named in honor of Mr. D. A. Crossley, Jr., my associate in the University of Kansas Chigger Project, who helped to collect the type series and successfully reared this species in the laboratory.

Description of larva.—Body: Holotype (partially engorged) 255 by 168 (unengorged 170 by 128, fully engorged 315 by 200), yellow in life. Eyes 2/2, bright red in life, subequal, ocular plate indistinct, length across both eyes 19, width 8.

Dorsal body setal formula 2-8-6-6-7-4-2-2, total 37 (36-38); humeral seta measures 30, anterior dorsal seta 24, posterior dorsal seta 21. Ventral setal formula approximately 2-2-2-7-7-5-6-6-4, total 41 (40-42); anterior sternal seta measures 19, third sternal seta 16, anterior ventral seta 17, posterior ventral seta 19. Total body setae approximately 78. (See Loomis and Crossley, 1953:33, figs. 1 and 2, for the general appearance of the body, as illustrated in the closely related *Trombicula trisetica.*)

Scutum: Subpentagonal, with a slightly angular posterior margin, the posterior corners slightly protruding; punctae small; posterolateral seta longer than anterolateral seta; sensilla flagelliform with 15 long branches on distal three fourths, several short barbs near base; bases of sensillae situated nearly equidistant between anterior and posterior margins of scutum, and nearly in line with the midpoints between antero- and posterolateral setae. Scutal measurements of holotype: AW- 34, PW- 46, SB- 12, ASB- 22, PSB- 20, AP- 22, AM- 20, AL- 17, PL- 27, S- 34. Averages and extremes of eight paratypes: AW- 35 (32-38), PW- 45 (43-47), SB- 12 (12-13), ASB- 20 (20-22), PSB- 20 (20-22), AP- 21 (20-22), AM- 20.5 (20-21), AL- 18 (17-19), PL- 26.5 (25-28), S- 33 (30-35).

Gnathosoma: Cheliceral blade long and slender, slightly curved; one prominent dorsal tricuspid cap; cheliceral base punctate. Galeal seta with a single branch (occasionally nude). Capitular sternum punctate, with one pair of branched setae. Palpal femur and genu each with a branched seta; three tibial setae each with at least one branch; tarsus with a basal spur (5μ), one stout branched seta, one seta with numerous branches and three setae each with one or two branches; palpal claw bifurcate, prongs nearly equal in length, inner prong axial, ventral and curved slightly inward.

Legs: Setation similar to *T. trisetica* except for number of setae on coxa III (see Loomis and Crossley, 1953:32-34). All leg segments with faint punctae. Nude setae and setae on coxa III are as follows: Leg I, three genualae and a microgenuala; two tibialae and a microtibiala; tarsus with a spur (11μ), microspur, subterminala, parasubterminala and pretarsala. Leg II, a genuala; two tibialae; tarsus with a spur (10μ), microspur, and pretarsala. Leg III, coxa with five branched setae (occasionally four or six on one side); a genuala; tibiala; and mastitarsala.

Remarks.—In the type series of 25 specimens the number of setae on coxa III are as follows: 12 with four and five setae; 10 with five setae; 2 with five and six setae; and 1 with six setae on both coxae. Mr. D. A. Crossley, Jr. successfully reared this species through a complete generation, from larvae taken with the type series. Paratype KU 3093 is a reared larva.

Specimens examined.—Total, 41 larvae, as follows. KANSAS. *Barber Co.:* 10½ mi. W Hardtner, *Melanerpes erythrocephalus,* July 26, 1952, KU 3069-93 (type series); 5 mi. S Sun City, *Melanerpes erythrocephalus,* Sept. 13, 1948, KU 3029-30; 4 mi. S Aetna, *Peromyscus leucopus,* Oct. 7, 1951, KU 3064-67, 3068 (3 specimens), 3098 (3), July 25, 1952, KU 3094. OKLAHOMA. *Comanche Co.:* Wichita Wildlife Refuge, *Peromyscus maniculatus,* KU 3095-96, and *Peromyscus leucopus,* KU 3097, May 16, 1952.

Trombicula (Leptotrombidium) twentei * sp. nov.

Figs. 4-9

Types.—Larvae: Holotype, slide KU 3101, and eight paratypes, KU 3102-3109, Snow Entomological Museum, University of Kansas, from 4 miles south of Aetna, Barber County, Kansas, taken from seven Bunker Bats, *Antrozous bunkeri* Hibbard, on February 25, 1953, by J. W. Twente, Jr.

Diagnosis.—Engorged larva large (body 782 by 484 in holotype), with a total of approximately 120 body setae; palpal femur, genu and tibia with nude setae; galeal seta branched; palpal claw trifurcate; scutum trapezoidal, with the posterior margin concave; sensillary bases near posterior margin, in line with the bases of PL's; sensilla long, flagelliform with several long distal branches; and no whiplike setae on Leg III. Possibly related to *Trombicula myops* Vitzthum, 1931 and *Trombicula (Leptotrombidium) mexicana* Ewing, 1937,† from bats in Venezuela and San Luis Potosí, Mexico, respectively, differing from *T. myops* in the greater number of body setae, 120, (67 figured by Vitzthum, 1931, for *T. myops*); other important characters of *T. myops* unknown to author. From

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* Named for Mr. John W. Twente, Jr., of the University of Michigan, who obtained the type series.

† Neither of these species has been examined by me. The type of *T. mexicana* is in the United States National Museum, according to Wharton and Fuller (1952:54). The location of the type of *T. myops* is unknown (*op. cit.*:67). Wharton and Fuller (*op. cit.*:51) defined the subgenus *Leptotrombidium*, and placed *T. mexicana* in it. *Trombicula twentei* is also placed in the subgenus, indicating a close similarity.

T. mexicana, T. twentei differs in having scutum with more pronounced punctae and concave posterior margin (rounded in *T. mexicana*), sensillary bases in line with bases of the PL's (anterior to PL's in *T. mexicana*), and 62 dorsal setae [as compared to 38-40 in *T. mexicana* according to Ewing (1937:173)].

Description of larva.—Body: Holotype (fully engorged) 782 by 434, pale in life. Eyes 2/2, anterior slightly larger, ocular plate faint, seen between paired eyes, distance across pair of eyes 24, greatest width 12.

Dorsal setal formula approximately 2-10-6-13-2-10-2-8-4-6, total 62; humeral seta measures 49, anterior dorsal seta 33-39, posterior dorsal seta 35. Ventral setal formula 2-2 plus 36 anterior and 18 posterior to anus; anterior sternal seta measures 39, posterior sternal seta 26, anterior ventral seta 25, posterior ventral seta 40. Total body setae approximately 120.

Scutum: Roughly rectangular or trapezoidal, with posterior margin concave, large scattered punctae, setae at apices, sensillary bases in line with bases of PL's, close to posterior margin. Sensilla long, flagelliform, with 13 long branches on distal two thirds. Scutal measurements: AW- 63, PW- 80, SB- 26, ASB- 34, PSB- 11, AP- 28, AM- 47, AL- 35, PL- 47, S- 77. Averages and extremes of the nine types: AW- 62 (58-66), PW- 79 (75-83), SB- 27.5 (25-29), ASB- 33 (31-34), PSB- 12 (11-13), AP- 29 (28-31), AM- 49 (47-52), AL- 36 (35-38), PL- 48 (46-53), S- 79 (76-83).

Gnathosoma: Cheliceral blade long and slender, slightly curved, one prominent dorsal tricuspid cap. Faint punctae on cheliceral base. Galeal seta with five branches (4-6 in paratypes). Capitular sternum with few scattered punctae and a pair of branched setae. Palpal femur, genu and tibia with all setae nude; tarsus with basal spur (8μ), one nude and five branched setae. Palpal claw trifurcate, with a large central prong and two small lateral prongs.

Legs: Leg I coxa, trochanter and basifemur each with one branched seta; telofemur with five branched setae; genu with four branched setae, two genualae and a microgenuala; tibia with eight branched setae, two tibialae and a microtibiala; tarsus with approximately 17 branched setae, a spur (23μ), microspur, subterminala; parasubterminala and pretarsala. Leg II coxa and trochanter each with one branched seta; basifemur with two branched setae; telofemur with four branched setae; genu with three branched setae and a genuala; tibia with six branched setae and two tibialae; tarsus with approximately 16 branched setae, a spur (20μ), microspur and pretarsala. Leg III coxa and trochanter each with one branched seta; basifemur with two branched setae; telofemur with four branched setae; genu with three branched setae and a genuala; tibia with six branched setae and a tibiala; tarsus with approximately 13 branched setae; no whiplike setae on leg III. All leg segments with faint punctae.

Remarks.—*Trombicula twentei* may be closely related to other bat-infesting chiggers, such as *Trombicula myops, T. mexicana,* and the Asiatic species, *T. insolli* Philip and Traub, *T. piercei* Ewing, and *T. revellae* Audy. The Asiatic species seem to resemble *T. twentei,* but the former have more nude setae on leg III.

Specimens examined.—Total, 9 larvae, of the type series.

Euschöngastoides subgen. nov.

Type.—*Trombicula* (*Euschöngastoides*) *hoplai* sp. nov.

Diagnosis.—Differs from other described subgenera of the genus *Trombicula* in lacking subterminala and parasubterminala on leg I, lacking nude setae on genual segments of legs II and III, and having only four branched setae and a basal spur on palpal tarsus. Seemingly not closely related to other species or subgenera in *Trombicula,* but probably closer to *Euschöngastia lacerta* Brennan, which possesses many characteristics of *Euschöngastoides* except for presence of clavate sensillae. *Euschöngastia lacerta* differs from the genus *Euschöngastia, sensu stricto,* in several important characters, and may actually belong in *Euschöngastoides* despite presence of expanded clavate sensillae.

Description of the subgenus.—Larva: Palpal claw trifurcate, with basal part long and slender; four branched setae and a short basal spur on palpal tarsus; scutum roughly rectangular, without punctae, and with five normal plumose setae; sensilla flagelliform and plumose; body setae plumose; tarsus I without subterminala and parasubterminala; genu II and III without nude setae (genualae); leg III without whiplike setae; coxa III with one seta.

Trombicula (*Euschöngastoides*) *hoplai** sp. nov.

Figs. 10-15

Types.—Larvae: Holotype, slide KU 3150, and 23 paratypes, KU 3129-3149 and 3177-78, Snow Entomological Museum, University of Kansas, from 4½ miles south, 1 mile west of Aetna, Barber County, Kansas, taken from three prairie dogs, *Cynomys ludo-*

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*Named for Dr. Cluff Hopla of the University of Oklahoma, in appreciation of his many generous donations of chiggers and chigger hosts from Kansas, Oklahoma and Utah.

vicianus (Ord), field no. RL520727-4, shot on July 27, 1952, by R. B. Loomis and D. A. Crossley, Jr.

Diagnosis.—Larva with palpal claw slender, trifurcate; palpal setae branched except for lateral tibial seta nude; palpal tarsus with only four branched setae and a short basal spur; galeal seta nude; scutum roughly rectangular without punctae; sensilla plumose, with branches or basal barbs along entire length; four humeral setae; first posthumeral row with 10-12 setae; total body setae approximately 106; tarsus I without subterminala and parasubterminala; leg II without genuala; leg III without genuala and without whiplike setae. Unique among described species of *Trombicula.* Relationship possibly with *Euschöngastia lacerta* Brennan, 1948. See discussion under diagnosis of the subgenus *Euschöngastoides.*

Description of larva.—Body: Holotype (partially engorged) 370 by 289 (engorged 670 by 493), white in life. Eyes 2/2, pink in life, anterior larger, ocular plate obscure, distance across both eyes 21, width 9.

Dorsal setal formula 4-12 (10)-2-8-8-10-8-4-2, total 58 (56-58); humeral seta measures 34, anterior dorsal seta 27, posterior dorsal seta 22. Ventral setal formula approximately 2-2-8-8-6 plus 20, total 46; anterior sternal seta measures 34, posterior sternal seta 26, anterior ventral seta 21, posterior ventral seta 23. Body setae plumose, total approximately 104.

Scutum: Roughly rectangular, wider than long, posterior margin slightly convex without distinct punctae, anterolateral seta usually arched (fig. 11); sensillary bases slightly anterior to bases of the posterolateral setae; sensillae with barbs on proximal half, enlarging to numerous branches on distal half. Scutal measurements of holotype: AW- 56, PW- 66, SB- 21, ASB- 22, PSB- 13, AP- 19, AM- 25, AL- 27, PL- 33, S- 53. Averages and extremes of five types: AW- 53 (51-56), PW- 65 (63-70), SB- 21 (21-22), ASB- 22 (21-23), PSB- 14 (13-16), AP- 19 (19-20), AM- 25 (24-26), AL- 26 (23-27), PL- 28 (26-33), S- 53 (50-56).

Gnathosoma: Cheliceral blade long and slender, slightly curved, one prominent dorsal tricuspid cap, cheliceral base punctate. Galeal seta nude. Palpal femur and genu each with one branched seta; tibia with dorsal and ventral setae branched, lateral seta nude; tarsus with basal spur (6μ) and four feathered setae. Palpal claw trifurcate, long and slender curving slightly inward, with prongs of unequal length.

Legs: Leg I coxa, trochanter and basifemur each with one branched seta; telofemur with five branched setae; genu with four branched setae, two long genualae and a microgenuala; tibia with eight branched setae, two stout tibialae and a microtibiala; tarsus with approximately 14 branched setae, a spur (10μ), microspur, and pretarsala. Leg II coxa and trochanter each with one branched seta; basifemur with two branched setae; telofemur with four branched setae; genu with three branched setae; tibia with six branched setae, two tibialae; tarsus with approximately 14 branched setae, a spur (16μ), microspur and pretarsala. Leg III coxa and trochanter each with one branched setae; basifemur with two branched setae; telofemur with three branched setae; genu with three branched setae; tibia with six branched setae and tibiala; tarsus with approximately 14 branched setae; no whiplike setae on leg III. All leg segments with faint punctae.

Remarks.—*Trombicula hoplai* has been found attached to the body rather than the ears of the hosts. The hosts were obtained in the plains and canyons in Kansas and Texas and in the lower elevations bordering the Rocky Mountains. Larval activity seems to be restricted to the summer.

Specimens examined.—Total, 50 larvae, as follows. COLORADO. *Mesa Co.:* 1 mi. SW Mack, 4600 ft., *Neotoma lepida,* Sept. 8, 1948, KU 3572-73. KANSAS. *Barber Co.:* 4 mi. S. Aetna, *Neotoma micropus,* Aug. 22, 1949, KU 3110-18, 3577, July 25, 1952, KU 3121-28—*Peromyscus leucopus,* July 25, 1952, KU 3119-20, Oct. 7, 1951, KU 3068, 3098; 4½ mi. S, 1 mi. W Aetna, *Cynomys ludovicianus,* July 27, 1952, KU 3129-3150, 3177-78 (type series). NEW MEXICO. *San Juan Co.:* 18 mi. N, 1 mi. E Farmington, 6000 ft., *Neotoma mexicana,* Aug. 10, 1949, KU 3574. TEXAS. *Wichita Co.:* Wichita Falls, *Citellus tridecemlineatus* July 25, 1953, KU 3575.

Trombicula fitchi * sp. nov.

Figs. 16-18, 20

Types.—Larvae: Holotype, slide KU 3181, and 53 paratypes, KU 3180 and 3182-88, Snow Entomological Museum, University of Kansas, from 4 miles south of Aetna, Barber County, Kansas, taken from several hundred cave bats, *Myotis velifer* (Allen), field no. RL490410-1, collected April 10, 1949, by R. B. Loomis, L. J. Lipovsky and K. A. Wolfenbarger; and nos. 3196-3240, second generation larvae, reared from engorged larvae with the same data.

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* Named in honor of Dr. Henry S. Fitch, Resident Naturalist at the University of Kansas Natural History Reservation, in appreciation of the constant aid and encouragement given the writer while studying chigger mites.

Diagnosis.—Larva with palpal claw trifurcate; palpal femur, genu and tibia with all setae branched; galeal seta with several branches; scutum pentagonal, posterior margin broadly rounded; sensilla flagelliform, with approximately 15 branches on distal two thirds, a few barbs on proximal third; first posthumeral row with six setae. Similar to *Trombicula* (*Neotrombicula*) *sylvilagi* Brennan and Wharton, but differs in lacking whiplike setae on leg III as well as other characters. Closely related to *Trombicula kardosi* sp. nov., with differences noted under *T. kardosi.*

Description of larva.—Body: Holotype (partially engorged) 400 by 265 (engorged 560 by 460, unengorged 180 by 163), yellow in life. Eyes 2/2, bright red in life, anterior slightly larger than posterior, ocular plate obscure; distance across both eyes 24, width 10.

Dorsal setal formula 2-6-6-4-4-4-2, total 28; humeral seta measures 55; anterior dorsal seta 46, posterior dorsal seta 41. Ventral setal formula 2-2-10 plus 28, total 42; anterior sternal seta measures 43, posterior sternal seta 33, anterior ventral seta 30, posterior ventral seta 34. Total body setae 70.

Scutum: Roughly pentagonal, posterior margin deeply rounded; punctae small and scattered; sensillae flagelliform with 12 and 14 branches on distal two thirds, two barbs on proximal third; bases of sensillae situated nearly in line with bases of posterolateral setae. Scutal measurements for holotype: AW- 68, PW- 79, SB- 27, ASB- 28, PSB- 29, AP- 24.5, AM- 42, AL- 32, PL- 55, S- 71. Average of ten specimens and extremes (four topotypes and six from Douglas County): AW- 65 (59-69), PW- 79 (71-82), SB- 26 (24-28), ASB- 28 (25-31), PSB- 31.5 (29-33), AP- 24.5 (22-28), AM- 43 (40-45), AL- 35 (32-37), PL- 55 (51-60), S- 70 (65-74).

Gnathosoma: Cheliceral blade long and slender, slightly curved, one prominent tricuspid cap, cheliceral base punctate. Galeal seta with five branches. Capitular sternum punctate, and with a pair of branched setae. Palpal femur and genu punctate and each with one branched seta; tibia with three branched setae; tarsus with spur (8μ) and six branched setae. Palpal claw stout, trifurcate, axial prong internal, outer prongs short.

Legs: Leg I coxa, trochanter and basifemur each with one branched seta; telofemur with five branched setae; genu with four branched setae, three long genualae and a microgenuala; tibia with eight branched setae, two stout tibialae and a microtibiala; tarsus with approximately 17 branched setae, spur (19μ), microspur, subterminala, parasubterminala and pretarsala. Leg II coxa and trochanter each with one branched seta; basifemur with two branched setae; telofemur with four branched setae; genu with three branched setae and a long genuala; tibia with six branched setae and two tibialae; tarsus with approximately 14 branched setae, spur (14μ), microspur and pretarsala. Leg II coxa and trochanter each with one branched seta; basifemur with two branched setae; telofemur with three branched setae; genu with five branched setae and a long genuala; tibia with six branched setae and a long tibiala; tarsus with approximately 12 branched setae. All leg segments with punctae. The branched setae on all legs seemingly with setules projecting from a single plane; however, most if not all leg setae actually with two rows of setules, not set far enough apart to always extend out on both sides of seta when mounted on a slide. Proximal leg segments with branched setae long and rodlike with numerous fine setules (Fig. 17.), while on distal segments most of setae shorter with fewer and larger setules. Tarsus III with at least one long branched rodlike seta reminiscent of the long whiplike setae or their replacements in the subgenus *Neotrombicula.*

Remarks.—The larvae of this species appear in the late fall and winter. These chiggers seldom attach in or on the ears, but are found over the body, legs and base of the tail of the host.

This species has been reared to the second generation from larvae taken at the type locality by L. J. Lipovsky.

Specimens examined.—Total, 222 larvae, as follows. KANSAS. *Douglas Co.: Sciurus niger,* Jan. 19, 1950, KU 3375; Lawrence, *Sciurus niger,* March 27, 1948, KU 3310-3313, March 29, 1952, KU 3385-89(7), Nov. 16, 1952, KU 3391; 4 mi. S, 2 mi. W Lawrence, *Sciurus niger,* Nov. 18, 1950, KU 3376-79 (9); 2 mi. S Worden, *Sciurus carolinensis,* Nov. 26, 1949, KU 3315-3353 -*Sciurus niger,* Nov. 26, 1949, KU 3354-59, Nov. 28, 1949, KU 3368-74, -*Sciurus carolinensis* and *S. niger* (mixed), Nov. 26, 1949, KU 3360-67; 4½ mi. W, 3 mi. S Baldwin, *Sciurus niger,* Nov. 28, 1951, KU 3382-84; 5 mi. N, 1 mi. E Lawrence, Univ. Kansas Nat. Hist. Reservation, *Elaphe obsoleta,* Sept. 10, 1952, KU 3390. *Jefferson Co.:* 5½ mi. N, ½ E Lawrence, *Sciurus niger,* Nov. 21, 1951, KU 3380-81. *Miami Co.:* 3 mi. E, 1 mi. S Fontana, *Sciurus,* Oct. 12, 1948, KU 3314. *Barber Co.:* 4 mi. S Aetna, *Myotis velifer,* April 10, 1949, KU 3180-3194 (second generation, KU 3195-3247); -*Neotoma micropus,* April 11-14, 1949, KU 3248-51 (second generation, KU 3252-3309). NEBRASKA. *Otoe Co.:* 3 mi. S, 2 mi. E Nebraska City, *Sciurus niger,* Oct. 10, 1953, KU 3392-96. ILLINOIS. *Piatt Co.:* Monticello, *Glaucomys volans,* Oct. 24, 1948, RML (12).

Trombicula kardosi * sp. nov.

Figs. 19, 21

Types.—Larvae: Holotype, slide KU 3151, and 25 paratypes, KU 3152-74, Snow Entomological Museum, University of Kansas, from 4½ miles west, 3 miles south of Baldwin, Douglas County, Kansas, taken from two fox squirrels, *Sciurus niger* Linnaeus, field no. RL511128-3, shot on November 28, 1951, by R. B. Loomis.

Diagnosis.—Larva similar to *Trombicula fitchi* sp. nov., but differs in having galeal seta with fewer branches; palpal femur, genu and tibia with nude setae; scutum with posterior angle wider and more shallow; with more marginate lateral edges anterior to bases of posterolateral setae; sensilla longer, with fewer branches; and in having the spurs on tarsi I and II slightly longer.

Description of larva.—Holotype (engorged) 510 by 350; yellow in life. Eyes 2/2, red in life, subequal, length across both eyes, 21, width 8.

Dorsal setal formula 2-6-6-4-4-4, total 26; humeral seta measures 55, anterior dorsal seta 48, posterior dorsal seta 45. Ventral setal formula 2-2 plus 40, total 44; anterior sternal seta measures 40, posterior sternal seta 39, anterior ventral seta 28, posterior ventral seta 44.

Scutum: Shape of scutum roughly pentagonal, posterior margin rounded, lateral margins indented just above bases of PL's; scattered small punctae. Sensillae with seven branches. Scutal measurements of holotype: AW- 64, PW- 80, SB- 23, ASB- 28, PSB- 28, AP- 24, AM- 45, AL- 33, PL- 52, S- 76. Average and extremes of five paratypes: AW- 67 (65-69), PW- 82 (80-85), SB- 25 (23-28), ASB- 28 (26-29), PSB- 28 (28-30), AP- 25 (24-26), AM- 45 (43-48), AL- 35 (33-38), PL- 52 (51-54), S- 79 (78-81).

Gnathosoma: Galeal seta with two branches (2-3 branches). Palpal femur and genu each with one nude seta; tibia with three nude setae; tarsus with spur (7μ) and six branched setae. Other characters as found in *T. fitchi*.

Legs: Branched and specialized nude setae similar to *T. fitchi*. Tarsus I with spur 21μ (21-22); tarsus II with spur 15μ (15-18). All coxae with distinct punctae, other leg segments with faint punctae.

Remarks.—*Trombicula kardosi* and *T. fitchi* are closely related, and they seem to be related to the subgenus *Neotrombicula,* although there are no whiplike setae present on leg III.

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* Named for Mr. Ervin H. Kardos, formerly of the University of Kansas and now studying chiggers in Korea, in recognition of his excellent study of the subgenus *Neotrombicula* in the Central United States.

Three specimens of *Trombicula fitchi* were recovered with the type series of 26 *T. kardosi,* from the same two fox squirrels (*Sciurus niger*). This was the only known coexistence of these species in a single locality. Like *T. fitchi,* this species seems to prefer the body surface to the ears of the mammalian hosts.

Mr. D. A. Crossley, Jr. has reared several nymphs, presumably of this species, from engorged larvae taken with the type series of *T. kardosi.*

Specimens examined.—Total, 28 larvae, as follows. KANSAS. *Douglas Co.:* 4½ mi. W, 3 mi. S Baldwin, *Sciurus niger,* Nov. 28, 1951, KU 3151-3174 (total 26) type series. *Allen Co.:* 6½ mi. S Humboldt, *Elaphe obsoleta,* April 27, 1947, KU 3175. UTAH. *Garfield Co.:* Panguitch Lake, Dixie National Forest, *Eutamias umbrinus,* Sept. 24, 1952, KU 3176.

Trombicula arenicola sp. nov.

Figs. 22-26

Types.—Larvae: Holotype, slide KU 3601, and 29 paratypes, KU 3602-3628, Snow Entomological Museum, University of Kansas, from 12 miles northeast of Liberal, Seward County, Kansas, taken from six kangaroo rats, *Dipodomys ordi* Woodhouse, field no. RL 480908-5, caught on September 8, 1948, by R. B. Loomis, L. J. Lipovsky and D. T. Clark.

Diagnosis.—Larva similar to *Trombicula montanensis* Brennan in having palpal claw trifurcate; scutum roughly pentagonal, with posterior margin broadly rounded, and all setae approximately the same length; sensilla flagelliform with distinct branches on distal two-thirds; coxa III with three or four setae; two pairs of sternal setae; and one mastitarsala III. *Trombicula arenicola* differs from *T. montanensis* in having the galeal seta with 2-3 distinct branches; tarsus I with spur (16μ) longer (12-13μ in *T. montanensis*); legs with branched setae having more numerous setules; body setae total approximately 74, dorsal setae 36, formula begins 2-8-8 (2-6-6 in *T. montanensis*), ventral setae 38; and in having the sensilla longer (average 74μ).

Description of larva.—Body: Holotype (slightly engorged) 213 by 192, (engorged 460 by 375), yellow in life. Eyes 2/2, red in life, anterior larger, faint ocular plate, length across both eyes 17, width 8.

Dorsal body setal formula 2-8(9)-8-6-6-4(6)-2, total 36 (to 38); humeral seta measures 41, anterior dorsal seta 31, posterior dorsal seta 35. Ventral setal formula approximately 2-2 plus 26 (to 30) anterior to anus, 14 (10-16) posterior to anus, total 38-44; anterior sternal seta measures 28, posterior sternal seta 28, anterior ventral seta 26, posterior ventral seta 34. Total body setae approximately 74 to 80.

Scutum: Subpentagonal, posterior margin broadly rounded, anterolateral setae slightly shorter than other subequal scutal setae, few scattered small punctae; sensilla flagelliform with approximately 12 branches on distal two thirds and several short basal barbs; sensillary bases in line with bases of PL's. Scutal measurements of holotype: AW- 59, PW- 82; SB- 26, ASB- 25, PSB- 21, AP- 24, AM- 31, AL- 33, PL- 37, S- 73. Averages and extremes of seven topotypes: AW- 58 (53-64), PW- 81 (75-92), SB- 26 (24-28), ASB- 26 (25-28), PSB- 22 (20-25), AP- 24 (20-27), AM- 32 (30-34), AL- 31 (26-33), PL- 35 (31-37), S- 72 (67-75).

Gnathosoma: Cheliceral blade long and slender, slightly curved, one prominent tricuspid cap, faint punctae on cheliceral base. Galeal seta with two to three branches. Capitular sternum with punctae and a pair of branched setae. Palpal femur and genu each with one plumose seta, tibia with dorsal and lateral setae nude, ventral seta with several branches; tarsus with basal spur (8μ), and six branched setae, and a terminal nude seta; palpal claw trifurcate, with central prong largest and curved inward.

Legs: Leg I coxa, trochanter and basifemur each with one branched seta; telofemur with five branched setae; genu with four branched setae, two genualae and one microgenuala; tibia with eight branched setae, two tibialae and one microtibiala; tarsus with approximately 14 branched setae, a spur (17μ), microspur, subterminala, parasubterminala and pretarsala. Leg II coxa and trochanter each with one branched seta; basifemur with two branched setae; telofemur with four branched setae; genu with three branched setae and a genuala; tibia with five branched setae and two tibialae; tarsus with approximately 12 branched setae, a spur (16μ), microspur and pretarsala. Leg III coxa with three setae (three and four, or four setae); trochanter with one branched seta; basifemur with two branched setae; telofemur with three branched setae; genu with three branched setae and a genuala; tibia with six branched setae and a tibiala; tarsus with approximately 12 branched setae and one mastitarsala. Legs with long plumose setae with numerous fine setules, particularly evident in the central segments but more difficult to separate from setae with fewer branches on the distal segments.

Remarks.—Specimens of *T. arenicola* from other localities agree in all important characters with the type series.

Trombicula arenicola was compared with ten paratypes from Montana as well as several hundred other specimens of *Trombicula montanensis,* from Colorado, Nebraska, Kansas, Oklahoma and Texas. The differences listed in the diagnosis were present in every specimen examined of both species. The two species were found within eight miles of each other in Seward County, Kansas, *T. montanensis* from 4 miles northeast and *T. arenicola* from 12 miles northeast of Liberal, suggesting a slight overlap in distribution. *Trombicula arenicola* was obtained from the sand-sage valley of the Cimarron River, and it was this sandy habitat that suggested the specific name.

The number of setae on coxa III shows a variation from three on both (16 specimens), three and four (9) and four on both coxae (5) in the type series of thirty specimens. This variation is similar to that found in *T. montanensis.*

Specimens examined.—Total, 119 larvae, as follows. ALBERTA: Lomond, *Citellus richardsoni,* June 25, 1950, RML (1), and the house mouse, *Mus musculus,* June 27, 1950, RML (6). UTAH. *Tooele Co.:* Tooele, Dugway Proving Ground, *Dipodomys microps,* Sept. 15, 1951, RML (6), Oct. 18, 1951, RML (4), -*Dipodomys ordi,* Oct. 24, 1951, RML (6), -*Perognathus parvus,* Aug. 28, 1951, RML (3). NEW MEXICO. *Santa Fe Co.: Dipodomys ordi,* Oct. 2 (2), 4 (4), 17 (6), 30 (2), Dec. 4 (3), 1951, all RML, and *Perognathus flavus,* Oct. 24, 1951, RML (8). COLORADO. *Prowers Co.:* Two Buttes peak, 4500 ft., *Neotoma albigula,* May 9, 1950, KU 3644-47 and *Dipodomys ordi,* May 11, 1950, KU 3648-68. KANSAS. *Seward Co.:* 12 mi. NE Liberal, Sept. 8-10, 1948, *Dipodomys ordi,* KU 3601-36, -*Perognathus hispidus,* KU 3637-42, -*Muscivora forficata,* KU 3643.

DISTRIBUTION OF PARATYPES

Paratypes of each species will be sent to the United States National Museum; Rocky Mountain Laboratory, Hamilton, Montana; and the British Museum (Natural History). Paratypes of all of the species, except *Trombicula twentei,* will be sent to The South Australian Museum, Adelaide; Dr. G. W. Wharton, University of Maryland; Dr. Charles D. Radford, Manchester, England; Museum National d'Histoire Naturelle, Paris, France; Army Medical Service Graduate School, Washington, D. C.; and Dr. J. R. Audy, Institute for Medical Research, Kuala Lumpur, Malaya.

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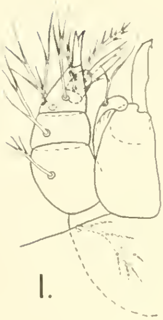
EXPLANATION OF PLATE I

Trombicula crossleyi sp. nov.

FIG. 1. Gnathosoma.
FIG. 2. Scutum and eyes.
FIG. 3. Coxa III.

Trombicula (*Leptotrombidium*) *twentei* sp. nov.

FIG. 4. Scutum and eyes.
FIG. 5. Anterior ventral seta.
FIG. 6. Anterior dorsal seta.
FIG. 7. Gnathosoma.
FIG. 8. Dorsal aspect of body.
FIG. 9. Ventral aspect showing nude setae on the legs.



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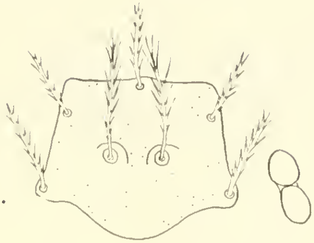

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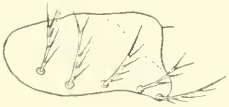

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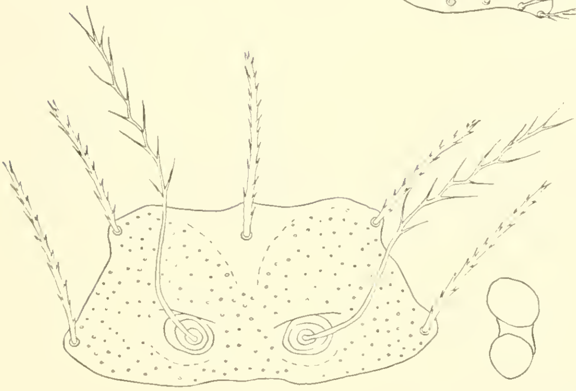

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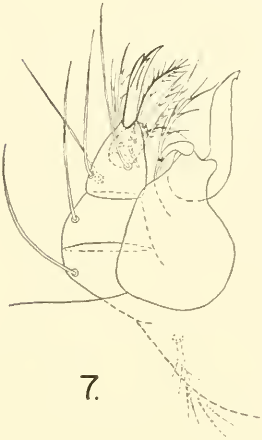

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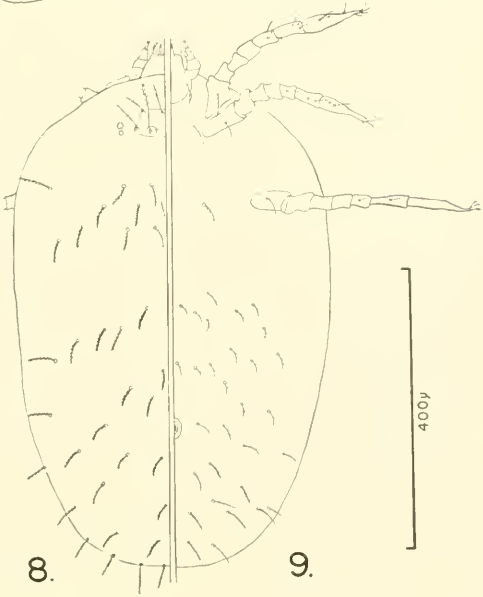
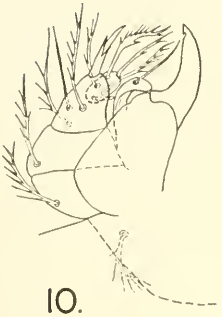


8. 9.

EXPLANATION OF PLATE II

Trombicula (*Euschöngastoides*) *hoplai* subgen. et sp. nov.

FIG. 10. Gnathosoma.
FIG. 11. Scutum and eyes.
FIG. 12. Dorsal aspect of body.
FIG. 13. Ventral aspect, showing nude setae of the legs.
FIG. 14. Anterior dorsal seta.
FIG. 15. Tibia and tarsus of Leg I.



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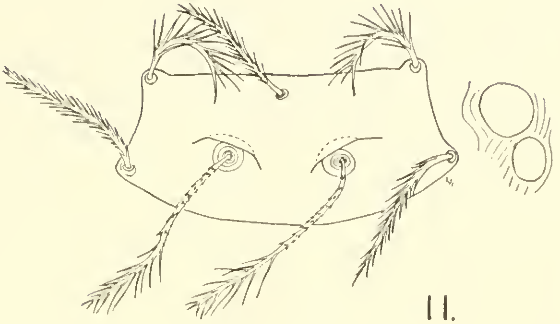

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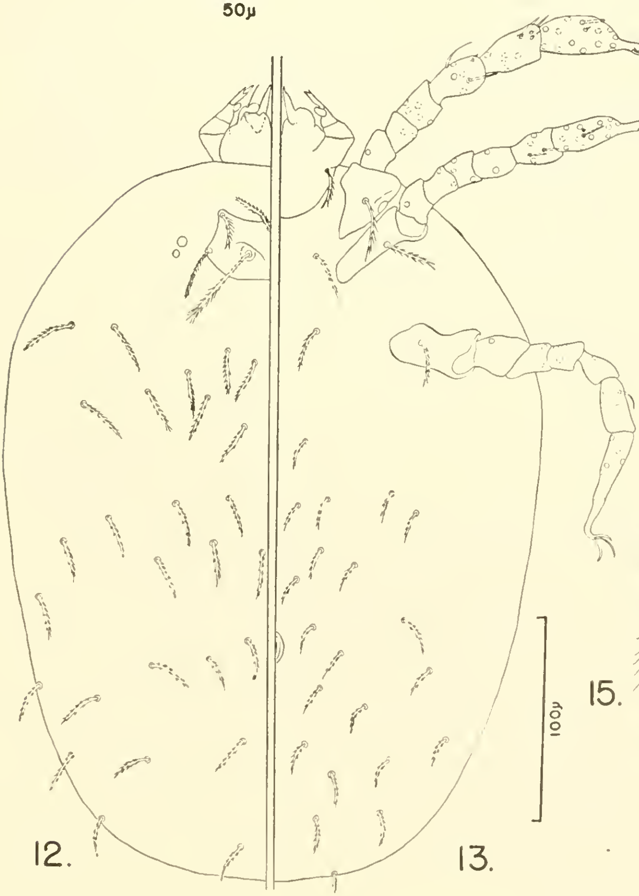

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13.

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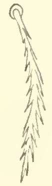
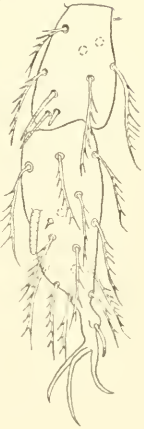




15.

EXPLANATION OF PLATE III

Trombicula fitchi sp. nov.

FIG. 16. Dorsal aspect of body.

FIG. 17. Ventral aspect, showing a long branched seta and nude setae on the legs.

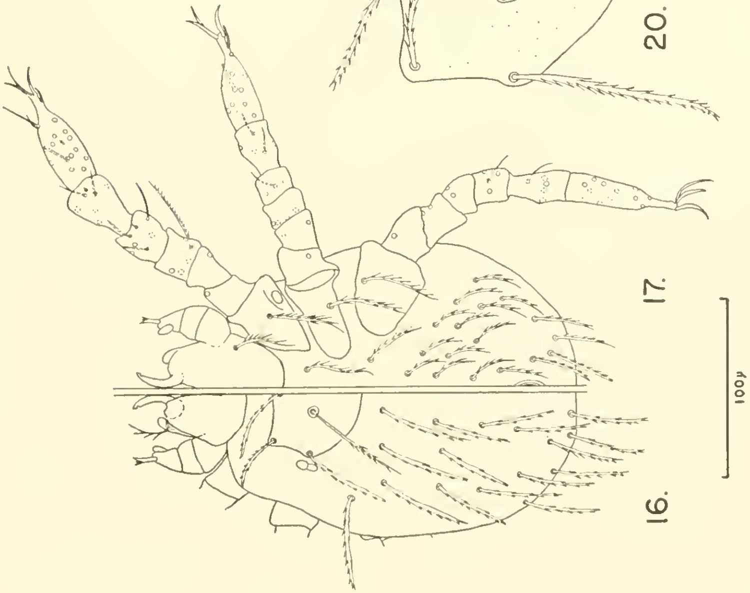
FIG. 18. Gnathosoma.

FIG. 20. Scutum and eyes.

Trombicula kardosi sp. nov.

FIG. 19. Gnathosoma.

FIG. 21. Scutum and eyes.



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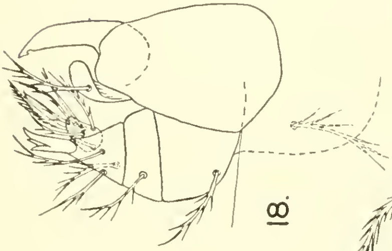

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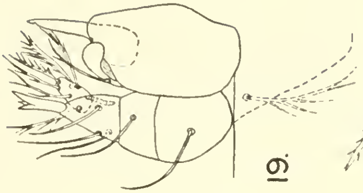

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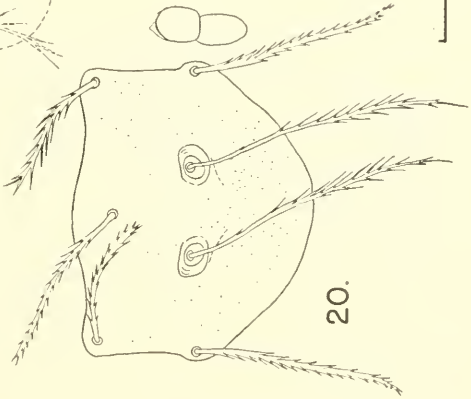

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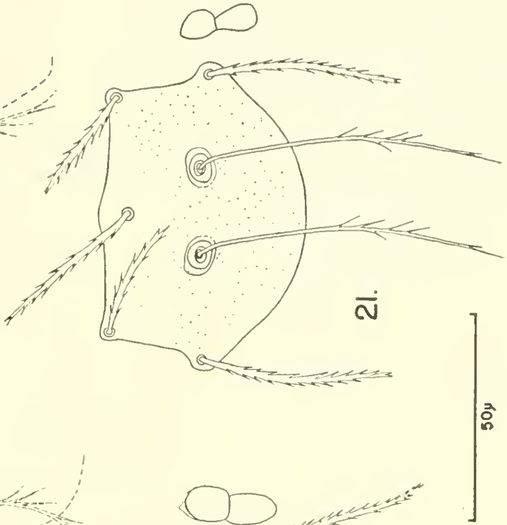
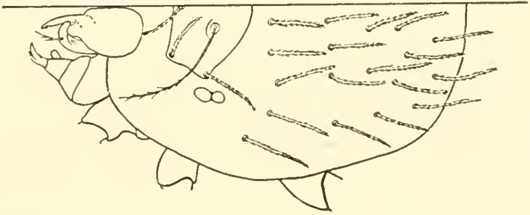


21.

EXPLANATION OF PLATE IV

Trombicula arenicola sp. nov.

FIG. 22. Dorsal aspect of body.
FIG. 23. Ventral aspect, showing nude setae on the legs.
FIG. 24. Gnathosoma.
FIG. 25. Scutum and eyes.
FIG. 26. Tarsus I.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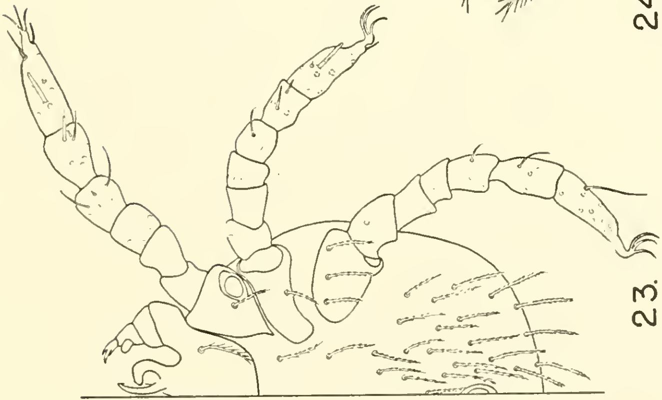
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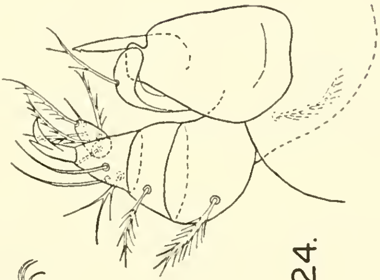
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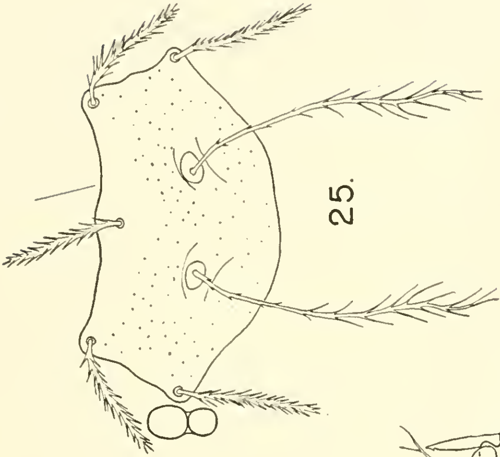
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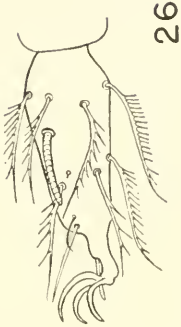
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Studies of the Food Habits of Postlarval Stages of Chiggers (Acarina, Trombiculidae)[1]

By

LOUIS J. LIPOVSKY[2]

ABSTRACT.—Although some nymphal and adult chiggers feed on quiescent stages of other small arthropods, those of our commonest chiggers utilize eggs of arthropods as their principal food. By offering postlarval chiggers laid eggs or dissected ovarian material of 21 arthropod orders (a total of 162 genera), considerable insight into normal foods was acquired. The Collembola, Diptera, Hemiptera, Homoptera, and Lepidoptera are the large orders which lay eggs attractive to chiggers. The Coleoptera and Orthoptera have relatively unattractive eggs. Certain eggs are toxic, at least when infected with *Penicillium*.

INTRODUCTION

This paper presents observations made over a period of four years on the feeding behavior of nymphal and adult chigger mites. During this time eggs, dissected ovaries and whole bodies of more than 150 genera of insects and other arthropods were offered to postlarval stages of chiggers and the success of the chiggers in making use of these foods was recorded.

Of all the groups of medically important arthropods, chiggers have been among the most difficult to rear, principally because of problems in feeding the postlarval stages. Curiously, this is the group in which rearing is most essential in disease transmission studies, for a chigger bites a vertebrate host but once and only in the larval stage (unless disturbed). Transovarian transmission is therefore an essential part of the disease-vector relationship, and rearing is necessary if laboratory transmission studies are to be completed.

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[1] Contribution No. 824, Department of Entomology, University of Kansas. The studies upon which this paper is based were conducted under a contract, N6 ori 220 Task Order II, between the University of Kansas and the Office of Naval Research.

[2] I wish to thank Drs. D. S. Farner, H. B. Hungerford, and C. D. Michener for aid in undertaking and pursuing the studies here reported. The manuscript was organized for publication by Dr. Michener with the aid of Dr. R. H. Beamer, D. A. Crossley, E. H. Kardos, and R. B. Loomis while the author was engaged in chigger investigations in Korea.

HISTORICAL ACCOUNT

Miyajima and Okumura (1917) succeeded in rearing *Trombicula akamushi* (Brumpt) in jars containing soil and supplied with fresh vegetable matter. Hatori (1919) did not succeed in duplicating this rearing experiment. Ewing (1925) offered springtail feces and dead springtails to a female *Trombicula alfreddugesi* (Oudemans) from which larvae were later obtained. Nagayo *et al.* (1921) offered decomposing vegetable matter to several species of *Trombicula.*

Michener (1946) succeeded in rearing *Trombicula* (*Eutrombicula*) *batatas* (Linnaeus) in Panamá although the food of the nymphs and adults was not known. The culture methods of Michener (1946) and of Melvin (1946) were similar; culture jars containing a mixture of soil and chicken manure were used. Michener's jars were "medium sized fruit jars with the bottom removed and replaced by a plug of plaster of Paris;" the jars were also lined with plaster of Paris. Michener concluded, "that living animals, portions of green plants (*e. g.*, rootlets), as well as excreta and freshly dead animals and plants are not necessary for the growth of nymphs and adults" of *T. batatas.* Also, ". . . that the nymphs and adults may feed on soil moisture rich in organic matter."

The best explanation of these observations appears to be that the chiggers were cannibalistic since these authors never succeeded in rearing isolated individuals. Cannibalism among chiggers is known; the quiescent forms are those most generally eaten. The insect or mite eggs in the soil or manure may have provided some food even though killed by heat, although this is improbable if the protein matter of these eggs coagulated during the exposure to heat.

The first feeding observations were those of Wharton and Carver (1946) and Wharton (1946) when the eggs of *Aedes aegypti* (Linnaeus), *Culex quinquefasciatus* Say, *C. jepsoni* Theobald, and *Drosophila* sp. were eaten; in addition, the dissected eggs of *Tribolium* sp., fly eggs, and the eggs and first instar larvae of ants were eaten by the postlarval stages of *Euschöngastia indica* (Hirst).

In 1947, Jenkins reared four generations of *T. alfreddugesi* and *T. splendens* (Ewing) with an approximate efficiency of seventy percent per generation. The food for the postlarval stages was the eggs of *Aedes aegypti,* but the large quantity of mosquito eggs required was noted as a disadvantage.

Jayewickreme and Niles (1947) used freshly killed Collembola or psocids, or eggs, ovaries or adults of *Mansonia uniformis* (Theobald). For routine feeding they used culicine eggs, primarily those of *Culex fatigans* Wied.

Jenkins (1948) suggested that mosquito eggs (*Aedes* and *Psorophora*) laid in dry depressions in the summer may serve as food for the adults of *T. splendens*.

Jones (1951) reported the failure of nymphs of *Trombicula autumnalis* (Shaw) to feed on "the eggs of various insects" (including *Aedes* eggs) offered to them. He successfully reared this species on a *Drosophila* culture medium consisting of yeast, agar, and molasses. The mixture was not readily taken; however, Jones induced the nymphs to ingest the mixture by forcing them into it. He adds, "The feeding behavior of many nymphs was inexplicable."

MATERIALS AND METHODS

The postlarval chiggers were reared from engorged larvae obtained principally from vertebrate hosts. Specimens of *Trombicula* (*Eutrombicula*) *alfreddugesi* and *T.* (*E.*) *splendens* were maintained for several years in mass cultures which supplied hundreds of individuals of both nymphs and adults for feeding trials. With a readily available supply of these two species, it was possible to isolate individuals or groups of individuals in culture dishes and from these withhold food for periods of two to three weeks before food was again offered. *Trombicula gurneyi* Ewing was also reared in mass cultures with *T. splendens*. Species not reared in mass cultures but used in the chigger feeding trials included *T. lipovskyi* Brennan and Wharton, *T. montanensis* Brennan, *Euschöngastia peromysci* Ewing, *E. lacerta* Brennan, *Pseudoschöngastia hungerfordi* Lipovsky, *P. farneri* Lipovsky, *Neoschöngastia americana* Hirst, and *Hannemania* spp. Of the species listed, the *Hannemania* and *Eutrombicula* are the least difficult to rear.

Most of the insects used in feeding trials were collected with an insect net or light trap. The specimens were drowned immediately in a one percent detergent solution (Aerosol O. T., Glim, or Joy) and then refrigerated. The selected freshly killed or refrigerated insect bodies were then placed with the chiggers in the culture tubes or dishes (Lipovsky, 1953). Successful feeding was most evident when dissected insect ovaries were offered to the nymphs and adults. In the Diptera, the laid eggs of the large crane-flies and of *Ptecticus* were obtained when these flies were held by hand and induced to lay their eggs.

FEEDING BEHAVIOR

The food of nymphal and adult trombiculids consists of a variety of insects and arachnids, their eggs, bodies, or fresh remains. It is probable that insects provide the major portion of this nourishment. It is reasonably certain that early (1917-1946) suggestions concerning other food sources were incorrect and that success of these authors in rearing occasional chiggers resulted from cannibalism or contamination of cultures with other arthropods. Food possibilities other than insects and arachnids may include such terrestrial forms as isopods and snails. The latter were a possible food source in laboratory mass cultures of *Trombicula splendens.*

Although little is known as to what foods are available and acceptable to postlarval chiggers in nature, there are indications from laboratory findings as to the probable feeding habits of a number of species of trombiculids in the subfamilies Trombiculinae, Walchiinae, and Leeuwenhoekiinae. In general, the feeding preferences support the morphological evidence relative to their probable phylogeny.

Neoschöngastia, Pseudoschöngastia and *Walchia* in the laboratory would not feed on any eggs or any ovarian material offered them. They ate instead freshly dead or maimed Collembola (*Sinella*) or Collembola immobilized by molting. In nature they also probably feed on resting stages of various small insects.

The nymphs and adults of *Trombicula* may utilize similar food, but as shown by the feeding trials reported below, most species apparently feed principally on insect eggs, and in the laboratory will feed on oöcytes dissected from female insects. Similar habits are characteristic of *Hannemania* and *Euschöngastia.*

SIMULATED FEEDING

Nymphs and adults often appear to feed on a variety of substances, both organic and inorganic, within their environment, but they apparently do not obtain nourishment except from the sources described above. Wharton and Carver (1946) state: ". . . even though the gnathosoma was pressed against the substratum and the opisthosoma was expanded and contracted, it is doubtful whether the nymphs were successful in taking food." When hungry, the nymphs and adults engage in simulated acts of feeding on the substratum as well as on bits of wood, fragments of loose plaster of Paris, or bits of other debris. These simulated acts of feeding may indicate that traces of food remain and are detectable.

Futile attempts to feed seemed to be rare in new culture dishes; but when suitable food was placed in a new dish and then all visible traces removed immediately, the areas contacted with the food became attractive to unfed adults. When the content of an insect egg was smeared on the substrate, that which was not absorbed was eaten; such spots remained attractive even after the dried egg content could no longer be taken successfully as food, and the removal of all visible traces did not remove the apparent interest in the area contacted by the food until many hours later. An empty egg shell is often subjected to repeated cheliceral punctures and may be of apparent interest as food for from one to several days.

FEEDING TRIALS

Chigger cultures were begun in the spring of 1948, when a variety of insects and their eggs (either as dissected ovaries or as laid eggs) were offered as food to the nymphs and adults. The ovaries of *Drosophila* were readily eaten but the quantity of food obtained from each female was too small and the laid eggs were not very satisfactory. *Dermestes lardarius* ovaries appeared to be repellent in most cases although a few punctures were made in the immature oöcytes. Dermaptera eggs were readily accepted but were not obtainable in great quantities. In view of these experiences an extensive series of trials, reported in Table I, was undertaken to determine what foods would be most useful for laboratory purposes as well as what foods are probably important in nature.

The large testes of a number of insects were offered to adult chiggers but no interest was ever shown in these organs.

Coincident with these feeding trials, several species of Collembola were cultured, and among these *Sinella curviseta* Brook proved to be ideally suited for providing food to chigger cultures (see Lipovsky, 1951). This springtail was kept in cultures with chiggers and was fed yeast pellets; eggs laid by the springtails provided chigger food, as did the immobile forms of these insects. Collembola eggs other than those of the Entomobryidae provided little or no food for chiggers.

Table I shows the results of feeding trials using cultures of *Trombicula*, principally the pest chiggers *T.* (*Eutrombicula*) *alfreddugési* and *T.* (*E.*) *splendens.* Others previously listed were present in some of the early cultures.

The insect eggs or ovaries offered to the chiggers listed above represent eighteen orders, and in addition to these, spider eggs, tick eggs, dissected phalangid eggs, and some mites and their eggs were offered. Dissections were often made from fresh specimens but more commonly insects preserved in detergent and water and refrigerated for as much as two weeks were used. No differences were observed between freshly dissected ovarian material and that preserved in this way, unless the tissues had been frozen. Ovarian materials that had been frozen seemed not acceptable to chiggers.

In Table I, numbers in parentheses represent number of trials. Under laid eggs the numbers correspond to number of eggs; under dissected eggs and oöcytes the numbers represent dissected entire ovaries; the number fifty generally represents groups exceeding, in some cases by several hundred, this number; below fifty the estimates are more precise.

Symbols used in the table are as follows:

—	Repellent to the chiggers.
O	No influence on the chiggers.
A	Attractive but eggs apparently too hard to puncture.
D	Delayed punctures in hard eggs.
C	Possibly eaten by Collembola cultured with chiggers.
X	Few eggs punctured.
XX	Frequent punctures.
XXX	All eggs punctured.
G	Good.
F	Fair.
P	Poor.

Conflicting symbols in a single row in a single column indicate that different trials gave different results.

Letters in the last column are judgments based not only on the feeding trials but on places where eggs are deposited by the insects concerned. The nymphal and adult chiggers involved live in the soil or about rotting wood.

The observations on feeding were principally visual, punctures being recorded if a chigger was observed feeding. Rarely, collapsed eggs were used as evidence of feeding and recorded as punctures.

TABLE I

Feeding Trials Based on Nymphs and Adults of Chiggers [principally *Trombicula* (*Eutrombicula*) *alfreddugesi* and *splendens*]

See text for explanation

ORDER and family	Genus	Laid eggs	Dissected mature eggs	Half grown oocytes	Small oocytes	Probable importance in nature
COLLEMBOLA						
Entomobryidae	*Sinella*	(50) XXX				?
	Undetermined	(50) XXX				G
Poduridae	Undetermined	(50) O				P
Sminthuridae	Undetermined	(10) O				P
ORTHOPTERA						
Locustidae	*Melanoplus*		(2) –O X	(1) O X	(2) O XX	P
	Dissosteira		(2) –O X	(2) –O XX	(2) XX	P
	Mermiria			(4) XX	(5) XXX	F
	Schistocerca		(1) –O	(1) –O X	(1) XX	P
	Syrbula				(3) XXX	F
Gryllidae	*Gryllus*	(12)A D X	(2) AD XX	(2) XXX		F
	Nemobius				(6) XXX	F
	Oecanthus				(5) XXX	P
Blattidae	*Periplaneta*	(1) O	(2) –			P
Tettigoniidae	*Neoconocephalus*		(2) O	(2) XX	(2) XXX	P
	Scudderia		(5) O	(5) XX	(5) XXX	P
Tettigidae	Undetermined				(1) C ?X	
NEUROPTERA						
Sialidae	*Sialis*		(10) XXX	(2) XX		P
Hemerobiidae	?*Hemerobius*		(3) XXX	(1) XX		P
Chrysopidae	*Chrysopa*		(14) XX	(3) XX		P
Ascalaphidae	Undetermined		(1) O			P
EPHEMERIDA						
Ephemeridae	*Hexegenia*		(25)AD XX			P
ODONATA						
Libellulidae	*Libellula*		(1) XXX	(1) XXX	(1) XXX	P
PLECOPTERA						
Perlidae	*Neoperla*	(20)A D X	(20) D XX	(20) XXX	(20) XXX	P
	Isoperla	(20)A D X	(20) D XX	(20) XXX	(20) XXX	P
MALLOPHAGA						
Trichodectidae	*Trichodectes*	(25) O				P
	Undetermined	(10) O				P
ANOPLURA						
	Polypax	(10) O				P
THYSANOPTERA						
	Undetermined		(1) XXX			P
HEMIPTERA						
Anthocoridae	Undetermined		(2) XXX	(2) XXX		P
Nabidae	*Nabis*		(1) XX			F
Neididae	Undetermined				(15) XX	F
Miridae	*Lygus*		(50) XXX	(50) XXX	(50) XXX	P
	Lopidea		(5) XXX	(5) XXX	(5) XXX	P
	Halticus		(10) XXX	(10) XXX	(4) XXX	P
	Deraeocoris		(2) XXX	(3) XXX	(3) XXX	P
Lygaeidae	*Geocoris*		(50) XXX	(10) XXX	(10) XXX	G
	Nysius		(50) XXX	(50) XXX	(25) XXX	G
	Lygaeus		(10) XXX	(10) XXX	(10) XXX	G
	Ischnodemus		(50) XXX	(50) XXX	(50) XXX	G
	Blissus		(5) XXX	(2) XXX	(3) XXX	G
Pentatomidae	*Brochymena*		(1) XXX	(2) XXX	(2) XXX	F-P
	Acrostermum		(1) XXX	(1) XXX	(1) XXX	F-P
	Thyanta		(2) XXX	(2) XXX	(2) XXX	F-P
	Euschistus		(3) XXX	(3) XXX	(3) XXX	F-P
	Undetermined	(20) A X			(1) –	F
Scutelleridae	Undetermined			(2) XXX	(2) XXX	F-P

TABLE I—Continued

ORDER and family	Genus	Laid eggs	Dissected mature eggs	Half grown oocytes	Small oocytes	Probable importance in nature
HOMOPTERA						
Cercopidae	Undetermined	...	(2) XX	(2) C ?X	(2) C ?	P
Membracidae	*Ceresa*	...	...	(4) XXX	(4) XXX	P
Cicadellidae	*Aceratagallia*	...	(5) XXX	(5) XXX	(5) XXX	P
	Exitianus	...	(10) XXX	(10) XXX	(5) XXX	P
	Draeculacephala	...	(50) XXX	(50) XXX	(25) XXX	P
	Graphocephala	...	(50) XXX	(50) XXX	(50) XXX	P
	Phelepsius	...	(25) XXX	(25) XXX	(10) XXX	P
	Gypona	...	(10) XXX	(10) XXX	(5) XXX	P
	Cicadula	...	(15) XXX	(15) XXX	(5) XXX	P
	Polyamia	...	(3) XXX	(3) XXX	(2) XXX	P
	Empoasca	...	(15) XXX	(10) XXX	(5) XXX	P
	Erythroneura	...	(15) XXX	(10) XXX	(5) XXX	P
Fulgoridae	*Scolops*	...	...	(4) XXX	(4) XXX	P
	Ormenis	...	(1) XXX	(1) XXX	(2) XXX	P
	Phylloscelis	...	(2) XXX	(2) XXX	(3) XXX	P
	Acanalonia	...	(5) XXX	(1) XXX	(1) XXX	P
	Poblecius	...	...	(4) XXX	...	P
(Delphacinae)	Undetermined	...	(50) XXX	(50) XXX	(25) XXX	P
Aphidae	Undetermined	(10) ?O	...	...	...	P
DERMAPTERA						
Labiduridae	*Labidura*	(50)A O XX	(25) XXX	(25) XXX	(25) XXX	F
COLEOPTERA						
Cicindellidae	*Cicindella*	...	...	...	(5) XXX	G
Carabidae	*Harpalus*	...	(5) O	(5) O X	(3) XX	P
	Pterostichus	...	(3) O	(4) O XX	(2) XX	P
Cantharidae	*Chauliognathus*	...	(10)– O X	(6)– O X	(10)– O ?X	P
Meloidae	*Epicauta*	...	...	(3) O X	(5) O XX	P
Elateridae	*Melanotus*	...	...	(2) X	(5) X	P
	Aeolus	...	...	(3) X	(5) X	P
Dermestidae	*Dermestes*	...	(5) –	(5) – O X	(10)– O X	P
Coccinellidae	*Adalia*	(20)– O	(2) – O	(3) O X	(6) O X	P
	Ceratomegilla	...	(4) – O ?X	(3) O X	(3) O XX	P
Tenebrionidae	*Tenebrio*	...	(5) O ?X	(5) O X	(2) O XX	F
Scarabiidae	*Phyllophaga*	...	...	(2) O X	(5) O X	P
Chrysomelidae	*Epitrix*	...	(10)– O XX	(6) O XX	(2) XX	F
	Cerotoma	...	(4) – O X	(2) O X	(2) XX	P
Curculionidae	Undetermined	...	...	...	(3) X	P
TRICHOPTERA						
	Undetermined	...	(25) XXX	(25) XXX	...	P
LEPIDOPTERA						
Eriocranidae	Undetermined	...	(2) XXX	XXX	XXX	P
Tineidae	Undetermined	...	(5) XXX	XXX	XXX	G
Gelechiidae	Undetermined	...	(5) XXX	XXX	XXX	P
Coleophoridae	Undetermined	...	(1) XXX	XXX	XXX	P
Tortricidae	Undetermined	...	(15) XXX	XXX	XXX	F
Pyralidae	Undetermined	...	(15) XXX	XXX	XXX	P
Pterophoridae	Undetermined	...	(15) XXX	XXX	XXX	P
Geometridae	Undetermined	...	(25) XXX	XXX	XXX	P
Notodontidae	Undetermined	...	(3) XXX	XXX	XXX	P
Phalaenidae	Undetermined	...	(10) XXX	XXX	XXX	G
Arctiidae	Undetermined	...	(3) XXX	XXX	XXX	P
Hesperiidae	Undetermined	...	(8) XXX	XXX	XXX	P
Pieridae	*Pieris*	(5) XXX	(6) XXX	XXX	XXX	P
	Colias	...	(2) XXX	...	...	...
Nymphalidae	*Brenthis*	...	(5) XXX	XXX	XXX	P
	Phyciodes	...	(5) XXX	XXX	XXX	P
Satyridae	Undetermined	...	(10) XXX	XXX	XXX	P
Lycaenidae	*Lycaena*	...	(10) XXX	XXX	XXX	P
	Thecla	...	(1) XXX	XXX	XXX	P
DIPTERA						
Tipulidae	Undetermined	(50)D XXX	(50) XXX	(50) XXX	...	G
Chironomidae	Undetermined	(25) XXX	(20) XXX	(20) XXX	...	F
Culicidae	*Culex*	(50) XXX	(30) XXX	(20) XXX	(10) XXX	P
	Aedes	(50) XXX	(20) XXX	(20) XXX	(5) XXX	G
Cecidomyidae	Undetermined	...	(20) XX	(15) XXX	...	G-P
Sciaridae	*Sciara*	...	(15) XXX	(5) XX	(5) XX	G

TABLE I—Concluded

ORDER and family	Genus	Laid eggs	Dissected mature eggs	Half grown oocytes	Small oocytes	Probable importance in nature
Mycetophilidae	Undetermined		(50) XXX	(50) XXX	(10) XXX	G
Stratiomyidae	*Ptecticus*	(30) –	(5) XXX	(7) XXX		P
Tabanidae	*Chrysops*				(5) XX	P
	Tabanus				(3) XX	P
Rhagionidae	Undetermined		(6) XXX	(6) XXX		F
Asilidae	Undetermined				(2) XX	F
Therevidae	Undetermined		(10) XXX	(6) XXX	(1) ?XX	G
Bombylidae	Undetermined			(2) ?XX		P
Empidae	Undetermined		(30) ?XX	(30) XX		G-P
Dolichopodidae	Undetermined		(50) XXX	(50) XXX	(20) XXX	G
Lonchopteridae	Undetermined		(10) XXX	(10) XXX	(2) XX	G
Phoridae	Undetermined		(10) XXX	(5) XX		G-P
Platypezidae	Undetermined				(2) XX	?
Syrphidae	*Mesogramma*		(20) XXX	(15) XXX	(15) XXX	G-P
Otitidae	*Eumetopiella*		(20) XXX	(30) XXX		P
Trupaneidae	Undetermined		(20) D XXX	(20) XXX	(10) XXX	P
Sepsidae	Undetermined		(20) X	(10) X		P
Ephydridae	Undetermined		(20) X	(10) X		F-P
Lauxaniidae	Undetermined		(5) XX	(5) XX		G
Drosophilidae	*Drosophila*	(50) O X	(25) XXX	(25) XXX		F-P
Agromyzidae	Undetermined		(50) XXX	(50) XXX	(50) XXX	P
Chloropidae	Undetermined		(50) XXX	(50) XXX	(50) XXX	G
Borboridae	Undetermined				(10) X	?
Tetanoceridae	*Haplodictyis*				(20) XX	?
Muscidae	*Musca*	(50) O X	(50) XXX	(50) XXX	(20) XXX	F
Anthomyidae	Undetermined		(50) XXX	(50) XXX	(10) XXX	G
Sarcophagidae	Undetermined	(20) O	(25) XXX	(25) XXX	(5) XXX	P
Tachinidae	Undetermined		(50) XXX	(50) XXX	(10) XXX	P
SIPHONAPTERA						
	Orchopeus	(10) O	(2) XXX			P
	Otenocephalides	(10) O	(3) XXX			P
	Nosopsyllus	(10) O				P
	Undetermined	(25) O				P
HYMENOPTERA						
Andrenidae	Undetermined				(3) X	P
Pompilidae	Undetermined			(3) O X	(5) X	P
Vespidae	Undetermined			(2) O X	(3) X	P
Ichneumonidae	*Ophion*		(3) O ?X	(5) XX	(1) X	P
	Paniscus		(2) XX	(3) X	(3) O X	P
Braconidae	Undetermined		(2) XXX	(5) XX	(8) X	P
PHALANGIDA						
	Undetermined		(2) XXX			G
ARANEIDA						
Lycosidae	Undetermined	(50) D XX				P
Aglenidae	Undetermined	(50) XXX				P
Undetermined		(50) XXX				P
ACARINA						
Ixodidae	*Amblyomma*	(50) O				P
Acaridae	Undetermined	(50) O X				P
Undetermined		(50) O				P

NOTES ON ARTHROPOD ORDERS AS SOURCES OF CHIGGER FOOD

These comments are based on the same species of chiggers which were used to provide the data for Table I.

1. *Collembola:*—As previously indicated (Lipovsky, 1951) only the entomobryids, with particular reference to *Sinella curviseta* Brook, are suited for culturing with chiggers. Eggs provide most of the food but molting or freshly dead postembryonic stages of *Sinella* were also eaten. *Sinella* requires no food in addition to active dry yeast, although some additional food may be available in the form of organic matter which is occasionally present in cultures. S. *curviseta* is easy to culture; however it apparently does better under fluctuating temperatures and a relative humidity of 80 to 100 per cent. It cannot withstand freezing, and occasionally old cultures lose their reproductivity for several weeks, presumably due to the accumulation of feces or to an overabundance of acarid mites.

2. *Orthoptera:*—The Orthoptera probably provide but little chigger food in nature, although eggs of some small crickets and grasshoppers may be eaten. The small oocytes of Locustidae, Gryllidae, and Tettigoniidae, and the mature eggs of *Gryllus* appeared most favorable as food for chiggers in the laboratory. The mature and half grown oocytes of some appeared to be repellent. The eggs of *Periplaneta americana,* removed from the ootheca, were obviously repellent.

3. *Neuroptera:*—The ovaries of Sialidae, Hemerobiidae, and Chrysopidae were about equal in value as food. Of eight hemerobiid eggs, seven were eaten within four and one half hours. The large leathery ascalophid eggs were of no influence even after the contents of one egg was exposed; also, these eggs deteriorated rapidly. The eggs of some Neuroptera may be available in nature, although they are probably of little importance.

4. *Ephemerida:*—Although Mayfly eggs may be available for culturing often in large numbers (squeezed from the females), they are very small. The eggs are punctured by adults only after repeated attempts (see Plecoptera). Because they are extremely small, the nourishment obtained after successful penetration of the egg shell was probably slight. It was not determined whether nymphs were capable of puncturing the eggs.

5. *Odonata:*—The mature eggs and immature oocytes dissected from one female of *Libellula pulchella* were estimated to be sufficient to feed 500 or more adults of *T. splendens.* The eggs and

oocytes were soft and readily eaten. From five to ten adults could feed from an egg simultaneously.

6. *Plecoptera:*—Both ovaries and laid eggs were used in these tests. The eggs were light to dark brown in color; the lightly pigmented eggs were punctured and eaten with but slight delay. The dark brown eggs usually remained in cultures for several days before they were eaten; the laid eggs were usually the darkest, and these eggs were found attached to many females. The probable reason for the delayed penetration of the dark eggs was their hardness. The successful but delayed penetration may possibly be explained by the fact that at each feeding attempt, whether successful or not, a clear liquid substance exuding from the mouthparts was placed on the egg. The repeated subjection of eggs to this saliva may soften the egg shells sufficiently for later penetrations. The cultures of chiggers feeding on *Neoperla* and *Isoperla* eggs contained from fifty to seventy-five adults and nymphs. The nymphs and adults moved from egg to egg wetting each egg repeatedly. In one instance only, the eggs of an unidentified stone-fly were thought to be toxic, apparently killing over half of a culture of fifty nymphs and adults.

7. *Mallophaga:*—The eggs of *Trichodectes* were obtained from a coyote, *Canis latrans* Say. The eggs of an undetermined Mallophaga were picked from the feathers of several species of birds. There was no evidence as to the age of the eggs or the development of the embryo; none of these eggs were eaten. Since the eggs are attached to feathers and hairs, they may not be available in nature. No dissections of the adults were made.

8. *Anoplura:*—Eggs obtained from the hairs of a rat, *Rattus norvegicus* (Berkenhout), were not eaten. As in the case of Mallophaga eggs, they may not be available in nature. No dissections of the adults were made.

9. *Thysanoptera:*—Many specimens were dissected before one was found with large eggs, and these contained well-advanced embryos with visible segmentation and red eye spots. The five or six embryos, or possibly parasites, were covered with a thin, hyaline membrane. While still within the opened abdomen, they were offered to *T. splendens* and were eaten within five minutes; the embryos only were eaten. Subsequently, 12 of 20 freshly dead adult thrips (not sexed) placed in a culture dish without being dissected were fed upon. The feeding punctures were made in the second to the fourth intersegmental membranes of the abdomen.

10. *Hemiptera:*—The eggs of many Lygaeidae, such as *Geocoris, Nysius,* and *Ischnodemus,* probably are available in nature. The mature eggs were eaten consistently, and remained acceptable in the laboratory for many days after removal from the insects. The immature oocytes of an unidentified pentatomid appeared to be repellent to *T. splendens* and *Sinella.* The laid eggs of large pentatomids appeared acceptable but many were too hard to be punctured.

11. *Homoptera:*—Some of the eggs of Homoptera may be found and eaten in nature; however, since most Homoptera lay their eggs in plant tissues, their eggs are probably uncommonly available to chiggers.

12. *Dermaptera:*—The eggs of some earwigs may serve as food in nature. Laboratory evidence has shown that freshly laid eggs were preferred, while eggs eight days old or older were ignored. The most consistent results were with mature dissected eggs in cultures of nymphs and adults. Most nymphs were not successful in puncturing large freshly laid eggs. When feeding on soft dissected ovaries, the entire "beak," palps, and the tarsi of the anterior pair of legs were buried deeply in the soft wet food.

13. *Coleoptera:*—Many eggs of the Coleoptera are probably available in nature. The laboratory evidence is confusing. There seemed to be a gradient in acceptance of the ovaries. Particularly in the Chrysomelidae, ovaries were thought to have toxic or lethal effects. Toxicity was also suspected in some of the Meloidae and Coccinellidae. Many large eggs were too hard to puncture. Some were apparently repellent, as in the Cantharidae, Dermestidae, Coccinellidae, and Chrysomelidae (See table I).

14. *Trichoptera:*—Although the larvae of caddisflies are aquatic, many adults are found considerable distances from water and their bodies with their eggs may become available in nature. The mature eggs of caddisflies compared with the eggs of small moths in attractiveness.

15. *Lepidoptera:*—Moth eggs probably offer more possibilities in nature than do the eggs of butterflies. In either case, many of their eggs are laid on plants and are hence unlikely to be available to chiggers, but some phalaenids and others lay their eggs in or on the soil.

16. *Diptera:*—The mature eggs of most Diptera were eaten in the laboratory. None seemed toxic, but some were not attractive.

The laid eggs of a stratiomyiid, *Ptecticus,* were repellent to chiggers as well as to *Sinella.* The hardest eggs were those laid by large Tipulinae but most of these were punctured, often days after they were laid. The laid eggs of *Musca domestica* and a few other muscids were not eaten, perhaps because the larvae were well formed in the eggs. The same condition seemed to exist with the Sarcophagidae and Drosophilidae. The larvae hatched from these eggs within 24 hours in most cases. Many eggs of Diptera may serve as food in nature.

17. *Siphonaptera:*—The laid eggs of fleas were not eaten. The dissected eggs of *Orchopeus* and *Ctenocephalides* compared favorably with those of Diptera. Under certain conditions, the eggs of fleas may be available to chiggers in nature.

18. *Hymenoptera:*—Mature eggs of Hymenoptera were difficult to find because the majority of their eggs are laid singly and their availability in nature must be negligible.

19. *Phalangida:*—The mature but soft eggs were readily eaten. Additional body content were offered but no interest was shown in material in other than ovarian.

20. *Araneida:*—One egg-sac of a lycosid spider was recovered from a female. The eggs were apparently freshly laid and many of these were punctured and eaten although a delay of a few days seemed to be necessary before some of the eggs could be punctured. No ovarian dissections were made upon the adult lycosid spiders. Several egg-sacs collected from under loose bark on trees and stumps apparently were the eggs of agelenid spiders. Two of these sacs contained relatively freshly laid eggs which were eaten. Eggs with noticeable embryonic development seemed unattractive and were not eaten. No ovarian dissections were made. A number of egg-sacs of undetermined spiders resembling those of Gnaphosidae (Drassidae) were found under rocks and stones, and beneath loose bark on trees and stumps. The eggs in the majority of these cases were in advanced stages of differentiation and showed pigmentation. Only the clear eggs were eaten.

21. *Acarina:*—The only ixodid (tick) eggs offered to chiggers as food were the eggs of *Amblyomma americanum* (Linnaeus). Although there was no evidence of advanced embryonic differentiation, these eggs were not eaten. These eggs were neither attractive nor repellent. Ovarian dissections were not made. The eggs of two species of acarid mites were often available in chigger cultures.

Only rare feeding attempts were made on these and none were positively determined as completely eaten but a few punctures were made by both nymphs and adults. Hypopial stages were not attacked by chiggers. However, one adult chigger was seen attacking a large acarid. Eggs of several small mites other than the acarids were often found in chigger cultures but none appeared to be eaten.

Under starvation conditions, the acarids attacked and successfully killed nymphal and adult chiggers. Those chiggers with slight imperfections or wounds in the integument were the first to be attacked and when thus affected by numerous acarids, adult chiggers were eaten within two days. The parts fed upon by the acarids were moist and the chigger was helpless against the attacks. Hypopi of the acarids also attached to the nymphs and adults of chiggers particularly in cultures maintained in large terraria. Frequently, more than a hundred hypopi were found attached to an adult chigger, on the legs, palpi, chelicerae, and other areas of the gnathosoma. The hypopi often occurred in clusters, attached to each other, and when on the anterior parts of the gnathosoma they interfered with feeding. Attachment lasted from one to three or even four weeks.

TOXICITY OF *SINELLA* EGGS

As noted in the preceding pages, eggs of a few kinds of arthropods seem toxic to chiggers. Those of *Sinella curviseta*, however, are normally nontoxic and very useful in rearing chiggers. On several occasions, however, they have proven extremely toxic to at least five species of chiggers. This toxicity was attributed to at least one unidentified species of fungus of the genus *Penicillium.* Cultures and the generic identification were made by Dr. N. M. McClung of the University of Kansas. One species was definitely responsible for a severe toxicity resulting in death of the nymphs and adults which fed upon the infected eggs of this collembolan.

This *Penicillium* infected the *Sinella* eggs both in chigger cultures containing *Sinella* and in pure cultures of the collembolans. The degree of toxicity appeared to depend upon the growth stage and perhaps the species of the mold within the eggs. The infected eggs were easily distinguished within a short time by the production of a pink pigment within the egg, although eggs were toxic to some degree before their pigmentation became apparent. When egg pigmentation was not pronounced, the chigger mites fed on several *Sinella* eggs and developed signs of inco-ordination, lethargy, and quiescence. Most generally, eggs with noticeable pink pigmentation produced the most strikingly toxic reactions. The penetration of the egg sometimes resulted in immediate effects, even to the cessation of feeding, with the chelicerae buried in the egg and a completely moribund condition. Nymphs and adults were equally affected and inactivity and perhaps death occurred within a very few minutes.

SUMMARY

The laboratory feeding trials suggest that the eggs of many insects as well as other arthropods may serve as food for postlarval chiggers in nature. Some eggs appeared to be repellent, toxic, or unattractive as food. The mature but unlaid eggs of some species were eaten, although the laid eggs of the same species were apparently repellent or not accepted. Some chiggers apparently do not feed on ovarian material but feed only on the fluids that may be obtained from the bodies of small quiescent arthropods.

Some insect eggs are apparently toxic; those suspected are some of the Plecoptera, and Coleoptera of the families Meloidae, Coccinellidae, and Chrysomelidae. The eggs of these may or may not be available to chiggers. The fact that the eggs of *Sinella curviseta* are normally nontoxic but when infected with a *Penicillium* they become extremely lethal supports the probability of toxic byproducts being produced by the fungus. However, this should not exclude the possibility that some eggs are naturally poisonous to chiggers.

Eggs believed to be the most important sources of food for nymphal and adult *Trombicula* are those of many Diptera, certain Hemiptera (*e. g.* Lygaeidae), a few Lepidoptera (some Phalaenidae), and entomobryid Collembola. Eggs of many Lepidoptera, Hemiptera, Homoptera, Trichoptera, and Araneida seem equally acceptable but because of the egg laying habits of most members of these groups, they are not readily available to the chiggers. Eggs of Orthoptera, Coleoptera, Mallophaga, Anoplura, Siphonaptera, and Acarina do not seem to be particularly attractive to chiggers.

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A Revision of North American Cryphalini (Scolytidae, Coleoptera)

By

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ABSTRACT.—This revisional study of the Cryphalini of America north of Mexico includes the known biological information in addition to the taxonomic treatment.

Prior to the completion of this work 91 species of the tribe were known from North America. Of these two are now reduced to subspecific rank, two are removed from the tribe, and 52 are placed in synonymy. In addition, nine species and one subspecies are described as new to science.

The new species include the following: *Cryphalus thatcheri, Cryptocarenus porosus, Hypothenemus beameri, H. distinctus, Stephanoderes andersoni, S. castaneus, S. hirsutus, S. liquidambarae,* and *Trischidias minutissima.* The new subspecies is *Taenioglyptes ruficollis coloradensis.*

New synonymy includes the following: *Cryphalus* Erichson (=*Trypophloeus* Fairmaire), *C. nitidus* (Swaine) (=*T. punctipennis* Hopkins), *C. salicis* (Hopkins) (=*T. concentralis* Hopkins); *Cryptocarenus floridensis* (Blackman) (=*Tachyderes floridensis* Blackman); *Ernopocerus kanawhae* (Hopkins) (=*Ernoporus kanawhae* Hopkins); *Hypothenemus californicus* subsp. *tritici* Hopkins (=*H. thoracicus* Hopkins), *H. columbi* Hopkins (=*H. abdominalis* Hopkins, *H. rufopalliatus* Hopkins, *H. brunneipennis* Hopkins, and *H. amplipennis* Hopkins), *H. eruditus* Westwood (=*H. pruni* Hopkins, *H. rumseyi* Hopkins, *H. asiminae* Hopkins, *H. hamamelidis* Hopkins, *H. punctifrons* Hopkins, *H. subelongatus* Hopkins, *H. nigripennis* Hopkins, *H. juglandis* Blackman, *H. citri* Ebling, and *Stephanoderes evonymi* Hopkins), *H. schwarzi* (Hopkins) (=*Cosmoderes schwarzi* Hopkins); *Procryphalus utahensis* Hopkins (=*P. salicis* Hopkins), *P. mucronatus* (Leconte) (=*P. idahoensis* Hopkins, and *P. populi* Hopkins); *Stephanoderes brunneus* Hopkins (=*S. frontalis* Hopkins), *S. dissimilis* (Zimmermann) (=*S. chapuisii* Eichhoff), *S. erectus* (Leconte) (=*S. brunneicollis* Hopkins), *S. georgiae* Hopkins (=*S. texanus* Hopkins, *S. pini* Hopkins, *S. salicis* Hopkins, *S. floridensis* Hopkins, *S. ficus* Hopkins, *S. soltaui* Hopkins, *S. lucasi* Hopkins, *S. virentis* Hopkins, and *Hypothenemus robustus* Blackman), *S. interstitialis* Hopkins (=*S. interpunctus* Hopkins, *S. approximatus* Hopkins, *S. flavescens* Hopkins, *S. opacipennis* Hopkins, and *S. quadridentatus* Hopkins), *S. nitidipennis* Hopkins (=*S. nitidulus*

Hopkins, and *S. subopacicollis* Hopkins), *S. obscurus* (Fabricius) (=*Hypothenemus hispidulus* Leconte, *S. seriatus* Eichhoff, *S. guatemalensis* Hopkins, *S. brasiliensis* Hopkins, and *S. lecontei* Hopkins), *S. rotundicollis* Eichhoff (=*S. sculpturatus* Eichhoff, and *S. quercus* Hopkins), *S. sparsus* (Hopkins) (=*Hypothenemus sparsus* Hopkins, *H. similis* Hopkins, and *S. tridentatus* Hopkins); *Taenioglyptes* Bedel (=*Cryphalus* of most authors), *T. fraseri* (Hopkins) (=*C. balsameus* Hopkins), *T. pubescens* (Hopkins) (=*C. subconcentralis* Hopkins), *T. ruficollis* (Hopkins) (=*C. approximatus* Hopkins, *C. grandis* Chamberlin, *C. canadensis* Chamberlin, and *C. mainensis* Blackman); *Trischidias atoma* (Hopkins) (=*Hypothenemus atomis* Hopkins, *H. impressifrons* Hopkins, *H. marylandicae* Hopkins, *H. robiniae* Hopkins, and *H. toxicodendri* Hopkins); *Plesiophthorus striatus* (Leconte) (=*Hypothenemus striatus* Leconte); *Cis terminalis* (Mannerheim) (=*Bostrichus terminalis* Mannerheim).

Species previously not recorded from this area include: *Stephanoderes nitidipennis* Hopkins, *S. obesus* Hopkins, *S. obscurus* (Fabricius), and *S. squamosus* Hopkins. Two species, *Cryphalomorphus jalappae* (Letzner) and *Stephanoderes rufescens* Hopkins, do not breed in this area.

Plesiophthorus striatus (Leconte), and *Cis terminalis* (Mannerheim) do not belong to the Cryphalini.

At present, including this work, 46 species and three subspecies of Cryphalini are known to occur in America north of Mexico.

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INTRODUCTION

The exceedingly minute bark- and twig-boring beetles of the tribe Cryphalini have received very little attention. Numerous species have been briefly described, but in the absence of revisional works and other taxonomic aids, identification has been virtually impossible. In order to partially alleviate that condition, the object of this work has been to redescribe and provide keys for the representatives of this group from North America north of Mexico, and to contribute toward our knowledge of their biology and phylogeny. While only the native species are treated in full, all of Hopkins' types, and representatives of practically all other known Neotropical species were examined in order to establish or avoid synonymy. During this investigation approximately 8,000 specimens of Cryphalini were examined; of these the author either collected or assisted in the collection of more than 5,000 from the western, central, and southern United States.

The group of genera allied to *Cryphalus* Erichson was recognized as distinct from other subdivisions of the Scolytidae as indicated by the usage of the names Cryphaloideae of Lindemann (1875), Cryphalidae of Eichhoff (1879), Cryphali of Blandford (1904), Cryphalinae of Tredl (1907), Hagedorn (1910a, 1910b), and Hopkins (1915a), and Cryphalina of Balachowsky (1949). Although the taxonomic rank employed by these authors varied from that of subfamily to tribe or subgroup, the genera included were essentially the same with the notable exception of Hopkins. His subfamily Cryphalinae included not only the group in question, but representatives of at least two or three quite unrelated tribes as well.

The tribe Cryphalini as treated here is a modification of Balachowsky's concept, and includes the following North American genera: *Procryphalus* Hopkins, *Ernopocerus* Balachowsky, *Cryphalus* Erichson (=*Trypophloeus* Fairmaire, and *Glyptoderus* Eichhoff), *Cryphalomorphus* Schaufuss (=*Lepicerus* Eichhoff, *Letznerella* Reitter, *Ernoporides* Hopkins, and *Lepicerinus* Hinton), *Taenioglyptes* Bedel (=*Cryphalus* of most authors), *Hypocryphalus* Hopkins (=*Dacryphalus* Hopkins), *Cryptocarenus* Eggers (=*Tachyderes* Blackman), *Stephanoderes* Eichhoff, *Hypothenemus* Westwood (=*Homococryphalus* Lindemann, and *Adiacretus* Hagedorn), and *Trischidias* Hopkins.

The only original attempt to classify the North American Cryphalini worthy of note was made by Hopkins (1915b) who added 64 new species to the ten previously recorded in these genera from

America north of Mexico. Many of his species were based not on existing morphological structures or even on individual variations, but on host plant records or imaginary characters. For example, the original descriptions of *Stephanoderes brunneus* and *S. frontalis*, each consisting of 21 words, clearly point out conspicuous differences in body color and spacing of the marginal teeth on the pronotum; however, the types are identical with respect to both features. Blackman (1922), attempting to follow Hopkins' classification of *Stephanoderes* and *Hypothenemus*, redescribed many of the species from Mississippi, but recognizing the existence of considerable confusion did not assign names to a third of those listed.

The Cryphalini are cosmopolitan in distribution, although the great majority of genera and species occur in the tropics. *Procryphalus* is confined to the coniferous forests of Canada and the high mountains of the western United States; *Cryphalus* has a similar North American distribution, but also occupies the same habitat in Eurasia. *Cryphalomorphus, Hypocryphalus,* and *Cryptocarenus* are tropical genera and reach only to the subtropical southern tip of Florida and possibly of Texas. *Ernopocerus,* although known only from a single specimen in North America, is confined to the temperate deciduous forests; *Trischidias,* known only from North America, evidently is also limited to this habitat. *Stephanoderes* and *Hypothenemus* are tropical in distribution except in North America where they range over most of the deciduous forest areas. *Taenioglyptes* in the western hemisphere is known only from the northern coniferous forests; however, in the eastern hemisphere it occurs from the northern coniferous forests of Eurasia to tropical Australia.

BIOLOGY

Contrary to popular belief host selection in the Cryphalini is not highly developed, except in the genus *Procryphalus* and in the following species of other genera: *Cryphalus thatcheri, Hypocryphalus mangiferae, Taenioglyptes rubentis, Stephanoderes liquidambarae,* and *Hypothenemus pubescens.* Possibly there are two or three additional species known from insufficient material to be recognized as monophagous. The North American species of *Cryphalus* and *Taenioglyptes,* while not host specific, are restricted to one genus or to a few closely related genera of trees. They may therefore be considered oligophagous. The species of *Cryptocarenus, Stephanoderes, Hypothenemus,* and *Trischidias* exhibit a variable degree of host specificity ranging from one or two host species to pronounced polyphagy. Some species of *Stephanoderes* and *Hypothenemus* utilize coniferous and monocotyledonous as well as dicotyledonous host plants. In Table 1, the number of host species and the number of times each species of beetle was collected from a known host is recorded together with an estimate of the probable degree of host selection. Those species confined to one or two plant genera are considered oligophagous; those collected from four or more host genera are considered polyphagous.

TABLE 1

A summary of host selection in North American Cryphalini including: the number of collections having host records, the number of hosts recorded, and an estimate of the degree of host specificity.

Species name	Number of Collections	Number of hosts	Monophagous	Oligophagous	Polyphagous	Doubtful
Procryphalus utahensis	10	1	*			
P. mucronatus	17	1	*			
Cryphalus nitidus	9	5		*		
C. salicis	4	2(?)		*		
C. populi	9	4		*		
C. thatcheri	5	1	*			
Cryphalomorphus floridensis	4	2		*		
Hypocryphalus mangiferae	6	1	*			
Taenioglyptes pubescens	13	4			*	
T. rubentis	5	1	*			
T. r. ruficollis	22	7		*		
T. r. amabilis	4	2		*		
T. r. coloradensis	3	3		*		
T. fraseri	17	2		*		
Cryptocarenus floridensis	28	15			*	
Stephanoderes hirsutus	16	9			*	
S. dissimilis	27	13			*	
S. rotundicollis	14	8			*	
S. erectus	4	4			*	
S. castaneus	35	23			*	
S. obesus	17	10			*	
S. brunneus	37	29			*	
S. interstitialis	53	20			*	
S. nitidipennis	23	16			*	
S. squamosus	11	8			*	
S. sparsus	2	2				*
S. obscurus	71	59			*	
S. andersoni	5	5			*	
S. liquidambarae	3	1	*			
S. georgiae	49	26			*	
Hypothenemus beameri	14	13			*	
H. c. californicus	2	2				*
H. c. tritici	37	24			*	
H. eruditus	109	61			*	
H. pubescens	4	1	*			
H. columbi	13	7			*	
Trischidias atoma	14	12			*	

Conclusive proof of polyphagy was found at the Subtropical Experiment Station in Homestead, Florida, where easily recognizable species such as *Cryptocarenus floridensis, Stephanoderes castaneus,* and *Hypothenemus beameri* were collected in an area less than 100 yards in radius from numerous (8, 12, and 17 host species respectively) introduced ornamental plants as well as from native species. The evidence of polyphagy presented in Table 1, and the absence of biological and morphological differences led to the conclusion that both *Stephanoderes obscurus* and *Hypothenemus eruditus*, collected from 21 and 22 species of introduced ornamental plants (at the Subtropical Experiment Station) respectively, are easily recognizable, widely distributed species, and are not composed of numerous, closely related, virtually indistinguishable, physiologically distinct forms as the writings of Hopkins (1915a, p. 209; etc.) suggest.

New galleries of the Cryphalini are generally started in weakened or dying parts of the host plant, usually in twigs or branches of trees, shrubs, vines, and some herbaceous plants, more rarely in dead bark or in the boles of larger trees. The portion of the host utilized and the type of galleries constructed by the beetles are generally characteristic of the genus and have some phylogenetic significance. Within each genus, however, tunnels of the various species are irregular, making specific determination impossible from the work alone.

The species of *Procryphalus* and *Cryphalus* usually tunnel in the outer bark of limbs or in boles larger than two inches in diameter; they seldom reach the cambium region. The galleries are of the simple cave type, about two to six millimeters wide and several times longer than wide; they are often U- or Y-shaped, or irregular as illustrated by Hagedorn (1904, p. 373). Their walls are stained black, presumably as a result of the growth of a symbiotic fungus which may assist the beetles in overcoming the living tissues of the host in which they live. The beetles are monogamous and both sexes are found in the galleries where repeated mating probably occurs since it is known in other scolytids, and since many mating pairs are found when the galleries in various stages of construction are opened. The eggs are deposited in clusters in the parental galleries. After hatching the larvae mine into the surrounding bark, often moving only four or five millimeters from their starting point; their course is very irregular.

The species of *Taenioglyptes* generally attack the boles of young, weakened, standing trees about four to eight inches in diameter, although it is not uncommon to find them in broken limbs and branches or in seedlings. The beetles are monogamous. Although both sexes may be present mating was not observed in the egg chamber, but was observed on the surface of the bark of the brood tree immediately following emergence. The egg chamber lightly engraves the cambium, and is of the simple cave type, frequently oval in shape although elongate egg tunnels may occasionally be present. The eggs are deposited in clusters around the periphery; the larval tunnels then radiate from the egg chamber, usually forming an irregular pattern, although the larval tunnels of *T. fraseri* observed at the Great Smokies National Park in *Abies fraseri* curved until they became parallel with the grain of the wood. It is not impossible that this was an adaptation to the extremely thin bark of this particular tree, and not characteristic of the species.

The galleries of *Hypocryphalus mangiferae* appear to be of the same general type as those of *Taenioglyptes;* however, the tunnels observed had been largely obliterated because of the heavy infestation. The beetles are monogamous, a pair occurring in nearly every parental egg chamber.

The tunnels of *Stephanoderes* and *Hypothenemus* generally are constructed in dying twigs or branches less than one inch in diameter, rarely in larger parts of the host. Each system of galleries includes a small central chamber located in the cambium region, but often extending to the pith. From this central chamber one or more brood galleries extends more or less parallel with the grain of the wood; part of those in any one gallery system may be located in the cambium region, part entirely in the wood, and part in the pith (Blackman, 1922, Fig. 71). In some *Hypothenemus* particularly, the central chamber is often reduced in size, and when the infestation of beetles is heavy it is not uncommon for the brood galleries of several systems of galleries to be connected. Where these compound galleries occur species or even generic boundaries are not recognized and several species, often representing different genera, may be found in the same portion of one tunnel. In one instance specimens of *Cryptocarenus floridensis, Stephanoderes castaneus, S. brunneus,* and *Hypothenemus beameri* were all removed from the same tunnel. The eggs of *Stephanoderes* and *Hypothenemus* are deposited individually or in small clusters in the brood galleries. Upon hatching, the larvae, at least in *Stephanoderes,* remain in the gallery and feed both by eating boring dust produced by the adult beetles and by enlarging their gallery. When mature they may form a series of individual pupal cells in part of one tunnel, separated from one another by plugs of frass. This habit is not consistently followed; additional observations are desirable. In some *Hypothenemus* the larvae may leave the brood chambers and make irregular tunnels in the inner bark; there evidently is considerable variation of this habit in larvae from a single gallery. In both genera the males are conspicuously smaller than the females and extremely rare. The males evidently live only a few days after transformation and seldom become fully sclerotized. They have not been observed to travel more than a few inches from their home gallery and evidently cannot fly. The female, when mature, flies to a suitable host where she begins a new gallery; she rarely is joined by a second female but never by a male.

The biology of *Cryptocarenus* is very similar to *Stephanoderes* except that the brood gallery is a rather large, extremely long tunnel constructed in the pith of small branches and stems. *Trischidias atoma* is more similar in habits to the *Hypothenemus* species; *T. minutissima* larvae and adults were obtained from minute cavities under fungus (?) pustules on the outer layer of bark of a Red Mangrove root. The species of both *Cryptocarenus* and *Trischidias* are sexually dimorphic; the males are of reduced size and rare.

The large number of specimens of *Cryphalomorphus floridensis* present and the fibrous structure of the hosts made observation extremely difficult; however, it appeared that both sexes participated in the construction of the new burrows which were located in the region of the pith.

In the southern states the species of Cryphalini evidently are active throughout the year; however, toward the north only the adult females of *Stephanoderes*, *Hypothenemus*, and *Trischidias*, and the larval and pupal stages of *Procryphalus*, *Cryphalus*, and *Taenioglyptes* survive the winter.

Among emerging *Taenioglyptes*, mating was observed on the outer surface of the brood tree, and since both sexes are present later in the egg chamber, repeated mating probably occurs there also; it was observed only in the egg chamber in *Procryphalus* and *Cryphalus*. In contrast, mating was never observed in *Stephanoderes*, *Hypothenemus*, *Trischidias*, and *Cryptocarenus* in spite of hundreds of series collected. Because the males in these genera are extremely rare (an average of more than 40 females per male), short lived, and fragile, it is doubtful if they are capable of mating with more than a very small percentage of the available females, and since only females in the northern states survive the winter, yet virtually all those surviving produce young (mated female scolytids are not known to overwinter and produce young without an additional mating in the spring), it is highly probable that the species in these genera are at least partially parthenogenetic.

INTRASPECIFIC VARIATION

In a group such as this, where relatively minute differences distinguish genera, every morphological detail must be utilized to separate species. Unfortunately one or two of these minute differences with taxonomic value occasionally vary between individuals or clones (?) of a particular population and are often misleading. For this reason combinations of several characters are utilized in the systematic section to distinguish species, making accurate determinations possible even though one or two structures may be absent from the specimens at hand.

SEXUAL VARIATION

The most consistent and often the only external morphological means of separating males and females is by the relative size and shape of the seventh and eighth abdominal terga. In the male both terga are visible, sclerotized, and pubescent (Fig. 41). In the female only the seventh tergum is sclerotized and pubescent (Fig. 42); it is larger than in the male and completely conceals the small membranous eighth tergum.

Within the tribe there is a progressive tendency toward sexual dimorphism (Figs. 1-4). The males and females of *Hypocryphalus* and *Taenioglyptes* are usually about equal in size and abundance. In *Procryphalus, Cryphalus,* and *Cryphalomorphus* about one-third of the males are slightly smaller than the females, but males and females are equal in abundance. The males of *Cryptocarenus, Stephanoderes, Hypothenemus,* and *Trischidias* are conspicuously reduced in size and extremely rare; the eyes are reduced in size; the antennal funicle has one less (?) segment than is the case with females; the club is more slender; some of the teeth may be absent from the anterior margin of the pronotum; the elytral striae are obscure; the frontal, pronotal, and elytral punctures are obscure or absent; and the pubescence is longer on the sides and declivity than in the females. These modifications reach their climax in *Trischidias* where only one male could be found while collecting more than 200 females. Determination of the dimorphic males is unusually difficult, since variation between individuals is often so extreme that keys and descriptions are meaningless.

In the genus *Taenioglyptes* the short, abundant elytral scales tend to be slightly larger in males than in females, this is particularly noticeable in *T. ruficollis.* In *Hypocryphalus mangiferae,* and to a lesser extent in other genera, the posterior margin of the fifth abdominal segment of the male is more broadly rounded than that of the female.

INDIVIDUAL VARIATION

Intraspecific variation in body length generally is inconspicuous, but may occasionally be rather striking. The greatest such variation occurred in *Stephanoderes dissimilis* where the difference in length between the smallest and largest specimens equalled 50 percent of the body length of the smallest; it is of interest that the smallest specimen is known to be the offspring of the largest. Fluctuations of this magnitude occurring within a single population are evidently due to environmental factors; for example, rapid drying of the host tissues during the larval stage usually results in smaller body size of the beetles affected.

Body color, as in other scolytids, has been observed to change with the age of living specimens from pale yellow to light brown to the mature color of dark brown or black. Frequently the asperate area of the pronotum darkens first, but its color may remain reddish until long after the mature color of other parts has been attained. Intraspecific differences in pubescence ordinarily result from damage caused to setae by rubbing, although variations in the length and width of elytral bristles are common.

The specimens of an entire series of a *Stephanoderes* or *Hypothenemus* species, particularly those obtained from a single system of galleries, often appear morphologically identical, and usually differ slightly from other such series. Additional series obtained from one gallery system in the same locality include specimens no two of which are alike, and may contain specimens identical with, or intermediate between, all possible combinations of characters found in the morphologically homogeneous series. While other characters such as the teeth on the anterior margin of the pronotum and the ratio of body length to width vary independently of other characters, the variation in elytral bristles of *Hypothenemus eruditus* is used to illustrate this observation. Four appropriate series collected at Homestead, Florida, July 10, 1951, were selected and each specimen examined to determine the relative width of one average bristle on the upper half of the second declivital interstriae. Results (Fig. 121) show 95 percent of the series collected from *Sambucus canadensis* have the elytral bristles two and one-fourth or more times as long as wide (about as in Fig. 114), while 93 percent of the *Tectona grandis* series have bristles less than two times as long as wide (about as in Fig. 113). Based on these series, two morphological species might be recognized; however, the series collected from *Bauhinia grandiceps* and *Hibiscus rosa-sinensis* are intermediate between these extremes and contain representatives approaching both extremes. The similarity of specimens within certain series is presumably due to the similarity of their genotypes, and may be explained by several generations of inbreeding (which is likely since the progeny mate, if at all, before leaving the parental galleries) or by parthenogensis, or a combination of the two. Variable series may result either from outbreeding or from the presence of more than one egglaying female in a single system of galleries. The analysis of series from other localities, either from the same or different host plants, yields results similar to those obtained in the above example; however, they are somewhat less conclusive because fewer specimens are available.

The frons of the species of *Cryphalus* may vary in a single series from weakly concave to slightly convex, and it may or may not have a median impression. In *Stephanoderes* and particularly in *Hypothenemus* a narrow median longitudinal groove, often present at the summit of a broad median longitudinal elevation, may vary within a population from rather broad and shallow to very narrow and deep, or occasionally may be entirely absent.

The number of segments in the antennal funicle is constant in the females, except that in *Stephanoderes castaneus* there are only three (rarely four) segments, instead of five. However, in many specimens of this species incompletely fused segments clearly indicate the fourth and fifth segments which are in the process of being lost (Fig. 21). The funicle of males of *Cryptocarenus, Stephanoderes,* and *Hypothenemus* normally consists of one less segment than that of the female, but the distal segment is often partially divided.

The number of denticulations on the anterior margin of the pronotum is often extremely variable, but in some genera is sufficiently constant to have taxonomic value. In *Taenioglyptes* these teeth are taxonomically useless; they vary from three to eight within a single population (Figs. 50-52), and instead of being symmetrically arranged, they all may occur on one side. In other genera, while one or two teeth may be absent or supernumerary, one side or the other will usually be normal and have taxonomic significance. Additions to, or subtractions from the normal number results in crowding or large gaps that ordinarily are quite obvious. As mentioned previously, the males of the sexually dimorphic species may lack one or even all of the marginal teeth; it is rather unusual to find one with the normal number.

Differences in the spacing of punctures of the pronotum, striae, and interstriae, and in the number of tibial teeth often occur between the right and left sides of a single specimen. These variations although interesting, usually are rare and not of sufficient magnitude to warrant discussion.

Geographical Variation

The unusual amount of individual variation within some populations complicated by the lack of it in other populations of sexually dimorphic species, and the absence of biological data and of specimens from critical localities have made the detection of geographical variation difficult. From the specimens available only two species, *Taenioglyptes ruficollis* and *Hypothenemus californicus*, exhibit consistent variations which warrant the recognition of subspecies. The frontal characters of *Stephanoderes obscurus* vary slightly in a north-south cline which changes with, but evidently is not due to climatic differences (see p. 1044). The teeth on the anterior margin of the pronotum in *Stephanoderes brunneus* show geographical differences. A discussion of this variation is included in the systematic section following the description of these species.

No ecological rules have been detected which could be applied to the Cryphalini. The distribution of most genera is restricted to a single climatic zone, and since host selection and morphological characters generally are not rigidly fixed the effects of climate and host are not readily apparent.

COMPARATIVE MORPHOLOGY

A classification of the higher categories in the family Scolytidae based on a consideration of all, or even a major part of the significant morphological characters is not available. It is therefore difficult to establish the relationship of the Cryphalini to other groups in the family, particularly when only about half of the known genera are available for study.

The tribe Cryphalini is included in the subfamily Ipinae (family Ipidae of Hopkins, 1915a; supertribe Ipini of Balachowsky, 1949), because the outer apical angles of the tibiae are not produced beyond the tarsal insertion, the anterior margin of the elytra are not armed, the head is never prolonged to form a short beak, and the pronotum usually conceals the head from above and is armed with asperities on the anterior slope. Within the Ipinae the tribe Cryphalini may be characterized as follows:

Antennal club flattened, with sutures indicated on both sides, but anterior and posterior faces dissimilar, sutures on posterior face more strongly procurved and extending nearer distal end than on anterior face; funicle three to five segmented; anterior slope of pronotum declivous and armed with rather large, isolated asperities, the anterior margin usually bearing one to nine denticulations; basal and usually lateral margins of pronotum with a fine, raised line; costal margins of elytra ascending posteriorly; metepisternum partly covered, by elytra, but visible its entire length; anterior coxae contiguous; tibiae increasing in width distally, and armed with three or more teeth on outer and distal margins, those on the posterior tibiae confined to the distal one third.

Based on the examination of representatives of virtually all of the genera of Holarctic and Neotropical Ipinae, the tribes most closely allied to the Cryphalini appear to be Micracini and Pityophthorini. These groups share the asperate anterior slope of the pronotum, the strongly flattened antennal club which is sutured on both sides and never obliquely truncate, and at least in some genera denticulations arm the anterior margin of the pronotum. At best these tribes are only remotely related and it is not impossible that the similarities mentioned have no phylogenetic significance.

COLOR

The body color of species of Cryphalini is usually uniform. The species of *Procryphalus, Cryphalus, Ernopocerus, Cryphalomorphus, Stephanoderes, Hypothenemus,* and *Trischidias* are brownish-black or black, except *Stephanoderes castaneus* which is a rather dark reddish-brown when mature; those of *Cryptocarenus* are a rather light reddish-brown; and those of *Taenioglyptes* and *Hypocryphalus* are rather dark yellowish-brown. The setae ordinarily are white in color with a slight yellow tint; in *Stephanoderes castaneus* they have a reddish tint, and in *Trischidias georgiae* and *T. minutissima* they are dusky at least on the declivity.

SIZE

The body length varies within the tribe from 0.5 to 2.5 mm. The limits of variation within a species are fairly well established, so that size alone is often useful in classification. The species of *Trischidias* and most *Hypothenemus* are readily recognized by their small size, and if only this feature is used they can be confused only with the males of a few of the smaller *Stephanoderes* species.

FRONS

The frons is very broad and distinctly convex in most species, often with a narrow, rather short median groove, or a broad median elevation. A few species have the lower half of the frons slightly concave with a transverse row of tubercles (*Cryptocarenus*) or a transverse carina (*Stephanoderes obesus, S. brunneus,* and *Hypothenemus columbi*) at its upper level. While presence or absence of the median groove and the contour of the frons are quite variable within many species, a combination of these characters serve as the only reliable means of separating *Stephanoderes obscurus* and *S. georgiae.* The surface is usually rather coarsely reticulate with a few fine punctures, these punctures are useful in separating *Procryphalus mucronatus* and *Stephanoderes andersoni* from allied species. The frontal pubescence is usually short and sparse.

EYE

The eye varies from rather long and slender in *Procryphalus* species to short and oval in the species of *Trischidias.* In some of the genera it is entire, or at most slightly sinuate along the anterior margin, however, in *Cryphalus* and *Hypothenemus* a few facets may be absent suggesting an emargination; in *Taenioglyptes, Hypocryphalus, Cryptocarenus,* and *Stephanoderes* it is clearly, though shallowly emarginate.

In *Cryptocarenus floridensis* the eyes are greatly enlarged, with a corresponding increase in size of the facets. While this is not found in *C. porosus,* it has been observed in other tropical representatives of the genus.

ANTENNA

The antennal funicle consists of from three to five segments in the female, the number usually being characteristic of the genus (except *Stephanoderes castaneus*). In the males of *Cryptocarenus, Stephanoderes, Hypothenemus,* and *Trischidias* the number of segments is ordinarily one less than that of the female. In addition to their number, the relative width of the funicular segments may be significant, for example, the second and most distal segments are of equal width in *Procryphalus, Ernopocerus, Cryphalomorphus, Hypothenemus,* and *Trischidias,* while in *Cryphalus, Taenioglyptes, Hypocryphalus,* and *Cryptocarenus* the distal segment is much wider than the second. In *Stephanoderes* there is complete intergradation between a very broad and a narrow fifth segment.

In outline the antennal club varies from circular to quite slender, and usually has one or two rather distinct constrictions at the sutures except in *Ernopocerus, Cryphalomorphus,* and *Hypocryphalus.* The sutures are indicated by rows of setae on both faces, the first suture may be completely septate, partly septate, or aseptate, but is constant within a genus. In the Cryphalini the anterior and posterior faces are dissimilar, the sutures on the posterior face are more strongly procurved and extend a greater distance toward the distal end of the club than those on the anterior face. On the anterior face the sutures may be recurved, straight, or strongly procurved.

PRONOTUM

Although quite variable within some species, the number of denticulations arming the anterior margin of the pronotum is of considerable taxonomic importance. Their number may vary from one in *Hypothenemus miles* to as many as ten in *Cryptocarenus floridensis.* These teeth normally are arranged in symmetrical pairs, the first or median pair is usually the largest, the second pair which is lateral to the first is somewhat smaller, the third pair is smaller than the second, etc. An abnormality in their arrangement, either the addition or loss of a tooth, results in crowding or wide spacing on one side and is ordinarily quite obvious when compared with the normal side.

The anterior slope of the pronotum is strongly declivous and bears several large, rather isolated asperities. The number and arrangement of the asperities is quite constant in the larger species of *Stephanoderes* and therefore is useful in their determination. The subconcentric arrangement of the asperities mentioned by Hopkins (1915a, p. 40) and Chamberlin (1939, p. 311) applies only to those asperities near the summit in certain specimens of *Taenioglyptes.* The subconcentric arrangement is obscure at best and may occur in an occasional specimen of almost any series of beetles belonging to this genus. The surface of the pronotum posterior to the asperate region is usually rather sparsely punctured, frequently some or all of the punctures are granulate. A seta usually arises from each puncture or granule, they may be either scalelike or hairlike.

The presence or absence of a fine, raised, basal and lateral line on the pronotum is used as one of the more important indicators of the direction of evolution within the tribe, and is the basis for a major division of genera. Only an obscure indication of a raised basal line is found in *Procryphalus* and *Ernopocerus;* the lateral line is absent in these genera. The species of *Cryphalus* and *Cryphalomorphus* have a distinct basal line, but the lateral line is absent in *Cryphalus,* and although present in *Cryphalomorphus,* it is not clearly defined by an acute lateral margin. Species in the remaining genera have both the lateral and basal lines distinct; the lateral line is present on only the basal one third, except in *Cryptocarenus* in which it extends for two thirds of the lateral length of the pronotum.

SCUTELLUM

While the visible portion of the rather large, flat scutellum is somewhat variable, both within and between species, this variation is not sufficient to be included in descriptions. Its use would increase rather than decrease the confusion of species.

ELYTRA

While the distinctly ascending posterior costal margins of the elytra are used as a tribal characteristic, there is some variation in this feature within the group. In *Procryphalus,* for example, the posterior ascension of the costal margin is only slight; in *Ernopocerus* and *Cryphalomorphus* it is more distinct, but not as prominent as in the other genera. Since the elytral striae and the strial punctures are quite variable within the tribe, they are most useful in the identification of some genera. The striae generally are quite narrow, as compared to the interstriae, and usually impressed; the strial punctures vary from minute, shallow, and obscure to very large and deeply impressed; each puncture bears a minute, inconspicuous, hairlike seta. The interstriae are either flat or weakly convex; their surface is punctured; the punctures vary from abundant and confused to a single, evenly spaced, uniserial row along each interspace. While the interstrial punctures usually are rather fine and shallow, they may be quite coarse, but more frequently are distinctly granulate. Each interstrial puncture gives rise to a seta which may be either hairlike or scalelike; on each interstria a uniserial row of widely spaced; bristlelike setae is much longer than the others. These larger bristles vary in length and width independent of the shorter, more abundant setae, and thereby afford exceedingly useful taxonomic characters. In those *Stephanoderes* species where only a single row of interstrial punctures persists, only the longer interstrial bristles remain, and between these bristles is a single row of the minute strial setae.

The elytral declivity is uniformly convex and rather steep in most species of Cryphalini, with the striae and interstriae essentially as on the disc. In *Cryphalus* species the declivity is slightly impressed between the first and fourth interstriae, and the lateral elevations may be armed with minute granules or small, slender teeth. In *Stephanoderes hirsutus* and *S. squamosus* the declivity is more or less flat; in addition *S. squamosus* has a low, subcarinate elevation at the posterior lateral declivital margin.

LEGS

The tibiae are of limited use in distinguishing species, but are of considerable taxonomic importance at the generic level. The tibiae of all three pairs of legs are rather broad in *Procryphalus, Ernopocerus, Cryphalus, Cryphalomorphus,* and *Taenioglyptes,* and bear several teeth. In *Hypocryphalus, Cryptocarenus, Stephanoderes, Hypothenemus,* and *Trischidias* the tibiae are more slender and bear fewer teeth; the teeth on the hind tibiae in these genera are almost entirely limited to the distal margins.

The third tarsal segments are cylindrical except in *Taenioglyptes* species in which they are broad and emarginate, in *Cryphalus* they appear laterally compressed.

PHYLOGENY

In selecting characters which indicate the probable direction of evolution in the Cryphalini many progessive modifications were observed to be consistent with those applying to the entire family, others to indicate specializations peculiar to the tribe. A summary of the presumably primitive and specialized external morphological characters observed in the tribe is presented in Table 2. None of the genera possess all of the primitive or all of the specialized characters listed.

The Cryphalini of North America represent only a fraction (less than one tenth) of the total number of genera and species belonging to this group throughout the world. They are primarily tropical in distribution and partly because of this many of them have been named from only one or two specimens and assigned to genera to which they are completely unrelated. For this reason a thorough study of their phylogeny is impossible until larger series of the tropical species are available.

The subfamily Ipinae geologically is very young as indicated (Schedl, 1952a) by its complete absence from Baltic amber or other fossil records of comparable age, although other scolytid groups with similar habits are quite common in amber. For this reason a knowledge of their phylogeny must be derived from the analysis of biological and morphological data.

The decision as to whether a character is primitive or specialized was based on such reasoning as the following. One of the most prominent divisions in the group is between the ordinary monogamous habit, involving the similarity of males and females, of the *Cryphalus* group of genera (including *Procryphalus, Ernopocerus,*

TABLE 2—A summary of the primitive and specialized external morphological characters observed in the Cryphalini.

Primitive	Specialized
Sexes similar in size and appearance.	Sexual dimorphism pronounced, males reduced in size.
Body size large.	Body size small.
Frons evenly convex.	Frons with carinae, tubercles, or impressions.
Eye elongate, entire, and finely granulate.	Eye short, oval, emarginate, and coarsely granulate.
Antennal funicle five-segmented.	Antennal funicle three-segmented.
Antennal club septate, the sutures straight.	Antennal club aseptate, the sutures procurved or recurved.
Fine raised line on basal margin of pronotum indistinct.	Fine raised line on basal margin of pronotum distinct.
Fine raised line on lateral margin of pronotum absent.	Fine raised line on lateral margin of pronotum distinct.
Asperities of pronotum small and abundant.	Asperities of pronotum large and sparse.
Anterior margin of pronotum broadly rounded.	Anterior margin of pronotum produced.
Summit of pronotum at middle.	Summit of pronotum near base.
Striae and strial punctures large and distinct.	Striae and strial punctures reduced, obscure, or absent.
Interstrial punctures abundant, and confused.	Interstrial punctures evenly spaced in uniserial rows.
Short interstrial setae scalelike.	Short interstrial setae hairlike, or absent.
Interstrial bristles widely spaced, in irregular rows.	Interstrial bristles closely placed, in uniserial rows.
Declivity uniformly convex.	Declivity with impressions, elevations, or granules.
Posterior costal margins of elytra ascending slightly.	Posterior costal margins of elytra ascending conspicuously.
Tibiae broad, with several teeth.	Tibiae slender, with few teeth.
Third tarsal segments cylindrical.	Third tarsal segments broad, or compressed.

Cryphalus, Cryphalomorphus, Hypocryphalus and *Taenioglyptes*), and that of the *Hypothenemus* group of genera (including *Cryptocarenus, Stephanoderes, Hypothenemus,* and *Trischidias*) in which the male is conspicuously different morphologically from the female and does not join her in the new gallery. Since the similarity of sexes occurs primarily in the more primitive groups of scolytids and of beetles generally, and sexual dimorphism only in those which are highly specialized, it must be concluded that the former group of genera is the more primitive, and the latter group the more specialized. It follows that in the Cryphalini the ordinary monogamous habit is more primitive than the behavior of the *Hypothenemus* group. In the *Cryphalus* group the eye may be elongate and is usually entire, the fine, raised basal and lateral lines on the pronotum may be obscure or absent, the posterior costal margins of the elytra may ascend only slightly, the short interstrial setae usually are scale-like, and the hind tibiae (with one exception) are rather broad, bearing teeth on both the distal and lateral margins; all of these characters are absent from the *Hypothenemus* group of genera, but do indicate a relationship with the more primitive genera in other scolytid groups, and therefore must be considered primitive. In the *Hypothenemus* group the eye is emarginate (except *Trischidias*); carinae, tubercles, or narrow impressions may occur on the frons; the fine raised basal and lateral lines of the pronotum are always present; the short interstrial setae are either hairlike or absent (with one exception); the interstrial punctures may be reduced to a single row; and the posterior tibiae usually bear teeth only on the distal margins. These characters are limited to the *Hypothenemus* group, and since to a large extent they contrast with those of the more primitive genera in other scolytid groups they are considered as specializations within the tribe Cryphalini.

Within the *Cryphalus* group some genera exhibit a greater number of the primitive or of the specialized characters than others; for example, all of the characters mentioned in the above paragraph as primitive are found in *Procryphalus,* and all except the elongate eye are found in *Ernopocerus.* On the other hand, *Taenioglyptes* and *Hypocryphalus* have several specialized characters such as the emarginate eye, the acute lateral margins of the pronotum, the distinctly ascending posterior costal margins of the elytra, etc., and therefore are considered more specialized than *Procryphalus* and *Ernopocerus.* The specialization of characters in *Cryphalus* and *Cryphalomorphus* is somewhat intermediate between these extremes.

Of the four genera in the more specialized group *Trischidias* quite obviously was derived from *Hypothenemus* and may represent only a specialized division of that genus. *Stephanoderes* and *Hypothenemus* are very closely allied, so much so that most of their distinguishing characters intergrade to such a degree that it is extremely difficult to distinguish them; additional information derived from tropical species eventually may result in the submergence of the name *Stephanoderes.* *Cryptocarenus* is entirely distinct from, but allied to *Stephanoderes* and possibly derived from this or a similar genus as indicated by the five segmented antennal funicle, the loss of the septum of the antennal club, the reduction or complete absence of the short elytral setae, and the shape and arrangement of teeth on the tibiae. These genera evidently descended from a common parental stock after the principal *Cryphalus-Hypocryphalus* characters had been acquired.

A thorough consideration of phylogeny in the tribe is quite impossible until representatives of a large portion of the tropical genera and species are available for study. Even minor divisions within some of the genera are known to be world wide in distribution; consequently the species of most North American genera are polyphyletic in origin thereby increasing this difficulty.

METHODS

At the time each series was obtained, except for the most common host species, a sample of the host plant was selected, pressed, and later submitted to specialists for determination. In the case of introduced ornamentals at the Subtropical Experiment Station in Homestead, Florida, the names were obtained from tags attached to the plants.

The beetles (at least those collected by the author) were killed and preserved in 70 percent ethyl alcohol; series of them were later mounted on paper points by the usual method to facilitate detailed study with a binocular microscope at magnifications up to 96 diameters. Tibiae and antennae were removed from dry specimens and mounted on glass slides either in Canada balsam or diaphane for study with a compound microscope at magnifications up to 440 diameters. The illustrations were prepared either from the dry specimens or from the prepared slides with the aid of an occular grid.

Measurements of length and width of the body, antennal club, and pronotum were made with the aid of an occular micrometer. The figures given for the relative measurements of these parts should be used with caution, since twisting or extension of intersegmental membranes of the thorax and (to a lesser extent) of the antennal club and the difficulty of measuring the pronotum from exactly the same angle with respect to the axis of the body cause distortion sufficient to greatly alter the measurements. The marginal teeth of the pronotum were not included in the measurement of the body or pronotum.

After completing the descriptive portion of the systematic section the Leconte collection at the Museum of Comparative Zoology, and the Hopkins, Blackman, and Eggers collections at the United States National Museum were visited in order to study the types of species included. Of the species treated here as native (and *Stephanoderes rufescens*), including their synonyms, the type specimen of each has been personally examined with the following exceptions. The type of *Cryphalus striatulus* is lost; the type of

Cosmoderes schwarzi is lost except for a balsam mount of the antenna (which was examined); cotypes of *Cryphalus amabilis* and *C. grandis,* and paratypes (?) of *Trypophloeus nitidus* were examined, their types could not be located and may never have been designated; the type of *Cryphalus mangiferae* was not available, but the type of Eggers' synonym, *Hypocryphalus mangiferae,* which he compared with the type of this species, was examined; the types of *Stephanoderes chapuisii, S. rotundicollis, S. sculpturatus,* and *S. seriatus* evidently are lost, presumably authentic specimens received from Eichhoff and comparing favorably with the original descriptions were examined; a specimen from Mexico compared with the type of *Hylesinus obscurus* by Eggers was used as the basis for this species; and specimens from the type series of *Hypothenemus eruditus* and *H. citri* were examined as the types were not available.

SYSTEMATIC SECTION

KEY TO THE GENERA OF NORTH AMERICAN CRYPHALINI

1. Pronotum without a fine, raised, lateral line (an indistinct line in *Cryphalomorphus*); eye sometimes sinuate, never emarginate; costal margin of elytra ascending only slightly posteriorly 2

   Pronotum acutely margined at the sides, and with a fine, raised line at least on the basal one third; eye emarginate (except *Trischidias*); costal margins of elytra distinctly ascending posteriorly 5

2. Antennal funicle five segmented; antennal club narrow, pointed at tip, sutures straight, not septate; basal half of pronotum without scalelike setae ...... *Cryphalus* Erichson

   Antennal funicle four segmented; antennal club broadly rounded at the tip, the sutures curved, partly septate, or both; basal half of pronotum with scalelike setae 3

3. Antennal club not septate, sutures indicted by three strongly procurved rows of setae ...... *Ernopocerus* Balachowsky

   Antennal club with at least part of first suture septate, none of sutures indicated by strongly procurved rows of setae 4

4. Sutures of antennal club straight, the first septate; anterior margin of pronotum slightly produced; pronotum with no indication of a fine, raised, lateral line ...... *Procryphalus* Hopkins

   Antennal club with a strongly oblique septum on one side, no other sutures indicated; anterior margin of pronotum broadly rounded; pronotum with an indistinct, fine, raised, lateral line, *Cryphalomorphus* Schaufuss

5. Antennal club not septate, with sutures indicated by rather strongly recurved rows of setae; third tarsal segments broad and emarginate ...... *Taenioglyptes* Bedel

Sutures of antennal club straight or procurved; third tarsal segments cylindrical 6

6. Antennal funicle five segmented (male usually four segmented); eye distinctly emarginate; body size greater than 1.4 mm. (except some *Stephanoderes brunneus* and S. *sparsus*) 7

Antennal funicle three or four segmented; eye sinuate to indistinctly emarginate; body size less than 1.4 mm. 9

7. Strial punctures obsolete; posterior half of pronotum finely granulate; antennal club large, not septate; male and female similar in size and appearance .... *Hypocryphalus* Hopkins

Strial punctures distinct; posterior half of pronotum not closely granulate, usually punctate; male much smaller than female 8

8. Antennal club not septate; raised lateral margin of pronotum extending two thirds of distance from basal margin to anterior lateral margin; elytra glabrous except for a few subcapitate interstrial bristles .... *Cryptocarenus* Eggers

First suture of antennal club partly septate; raised lateral margin extending only one third of distance from basal to anterior lateral margin; elytra clothed with rows of strial and interstrial setae, *Stephanoderes* Eichhoff

9. First suture of antennal club partly septate; body slender, more than 2.4 times as long as wide; striae and strial punctures not as strongly impressed; usually larger than 1.1 mm., *Hypothenemus* Westwood

Antennal club not septate; body stout, less than 2.3 times as long as wide; striae and strial punctures more strongly impressed; smaller than 1.1 mm. .... *Trischidias* Hopkins

Procryphalus Hopkins

Procryphalus Hopkins, 1915, U. S. Dept. Agr., Rep. no. 99, p. 33; Swaine, 1918, Dom. Can. Dept. Agr., Tech. Bull. 14, p. 90; Leng, 1920, Catalogue of the Coleoptera of America North of Mexico, p. 340; Chamberlin, 1939, The Bark and Timber Beetles of North America North of Mexico, p. 320.

The genus *Procryphalus* is distinguished from the other North American genera of Cryphalini by the absence of a distinct raised line on the basal and lateral margins of the pronotum, the presence of a complete septum in the first suture of the antennal club, and by the only slightly ascending posterior costal margins of the elytra. It is evidently more closely allied to *Ernopocerus* and *Cryphalus* than to other Holarctic genera.

Frons convex, rather broad, punctured, with scanty pubescence. Eye elongate-oval, about three times as long as wide, entire, and finely granulate. Antennal club elongate-oval, indistinctly constricted, with two distinct, straight sutures, the first completely septate, the second indicated by setae, the third rather obscure; funicle four-segmented, the fourth segment only slightly wider than the second.

Pronotum about equal in length and width; fine elevated line on the lateral margin of pronotum absent, obscure or absent on the basal margin; summit in front of the middle; asperate anterior and lateral to summit, asperities rather small, numerous; anteromedian margin slightly produced and armed with several teeth. Fore tibiae with teeth confined to the distal two fifths of outer margin. Hind tibiae broad, with five teeth on distal one fourth. Third tarsal segments cylindrical.

Elytral striae distinct or not, punctures variable; interstriae granulate-punctate; declivity rather steep, convex, without special elevations or impressions; vestiture consisting of abundant, short, semierect, scalelike setae, and uniserial rows of rather sparse, longer, interstrial, scalelike bristles.

The sexes are similar in size and proportions, but may be distinguished by the terga of the seventh and eighth segments.

Type Species: (*Procryphalus populi* Hopkins =) *Cryphalus mucronatus* Leconte, original designation.

KEY TO THE SPECIES OF PROCRYPHALUS

1. Strial punctures large, close; interstriae narrower than striae, punctures fine, sparse, surface smooth except for punctures; in *Acer macrophyllum* .... *aceris*
   Strial punctures of small to medium size; interstriae as wide or wider than striae, punctures more numerous, confused, surface granulate, at least near the elytral base 2
2. Smaller than 1.7 mm.; frons rather sparsely, shallowly punctured; interstriae more sparsely, finely punctured on posterior three-fourths of disc; in *Salix scouleriana* .... *utahensis*
   Larger than 1.8 mm.; frons coarsely, rather deeply punctured; interstriae densely, rather coarsely granulate-punctate over entire disc; in *Populus tremuloides* .... *mucronatus*

Procryphalus aceris Hopkins

(Figs. 46, 85)

Procryphalus aceris Hopkins, 1915, U. S. Dept. Agr., Rep. no. 99, p. 33; Chamberlin, 1917, Can. Ent., vol. 49, p. 355; Chamberlin, 1939, The Bark and Timber Beetles of North America North of Mexico, p. 321.

The strial punctures larger, the interspaces much narrower than the striae, the interspacial punctures fine, less numerous and more nearly in uniserial rows, and the pronotum with only six marginal teeth separate this species from the closely allied *P. utahensis*.

Female: Length 1.55-1.65 mm., about 2.8 times as long as wide, body color dark brown to black.

Frons weakly convex, moderately, shallowly punctured, slightly impressed above the epistoma, an indistinct median ridge extending from the upper level of the eyes to the epistomal margin; pubescence consisting of inconspicuous, sparse, fine, long hair. Eye elongate-oval, slightly wider above, about three times as long as wide, entire. Antennae missing from the two specimens at hand.

Pronotum about as long as wide; rather strongly produced on anteromedian margin and armed with six teeth, the third pair smaller and more widely spaced; summit anterior to middle; asperate in front of and to the sides of summit; asperities rather small, abundant; posterior and lateral areas rugose, sparsely, coarsely granulate-punctate; pubescence consisting of moderately long hairlike setae on the asperate area, and rather short, narrow scalelike setae on the granulate-punctate area.

Elytra shining; striae not impressed, the punctures large, deep, distinct, separately by slightly less than their own diameters; interstriae much narrower than the striae, the surface smooth except for small, widely spaced, usually subgranulate punctures, not coarsely granulate near the base. Declivity steep, convex; strial and interstrial punctures reduced in size and not as deep as on the disc. Elytral vestiture consisting of abundant, short, confused, semirecumbent, interstrial scalelike setae, and longer, rather sparse, uniserial rows of scalelike interstrial bristles.

Male: Similar to the female.

Type Locality: Albany, Oregon.

Host: Acer macrophyllum.

Distribution: Known only from the type locality.

The type specimen of *P. aceris* is in the U. S. National Museum.

Procryphalus utahensis Hopkins

(Figs. 6, 7, 25, 33, 47, 86)

Procryphalus utahensis Hopkins, 1915, U. S. Dept. Agr., Rep. no. 99, p. 33; Chamberlin, 1939, The Bark and Timber Beetles of North America North of Mexico, p. 321; Wood, 1951, Proc. Utah Acad. Sci., vol. 26, p. 128.

Procryphalus salicis Hopkins, 1915, U. S. Dept. Agr., Rep. no. 99, p. 33; Chamberlin, 1939, The Bark and Timber Beetles of North America North of Mexico, p. 321.

This species is somewhat intermediate between *P. mucronatus* and *P. aceris,* differing from both by the presence (normally) of eight teeth on the anterior margin of the pronotum, and the anterior one sixth of the elytral interstriae much more coarsely granulate-punctate than on the posterior two thirds of the disc.

Female: Length 1.5-1.7 mm., 2.73 times as long as wide, body color dark brown to black.

Frons weakly convex, moderately, shallowly punctured, weakly impressed above the epistoma, an indistinct median ridge extending from upper level of eyes to epistomal margin; pubescence consisting of inconspicuous, sparse, fine, long hair. Eye elongate-oval, slightly wider above, about three times as long as wide, entire. Antennal club longer than scape, about 1.60 times as long as wide, with three straight sutures on anterior face, the first suture septate.

Pronotum about as long as wide; rather strongly produced on anteromedian margin, and armed with eight teeth, the third and fourth pair smaller and more widely spaced, often submarginal; summit anterior to middle; asperate in front of and to sides of summit, the asperities rather small, abundant; posterior and lateral areas rugose, sparsely, coarsely granulate-punctate; pubescence consisting of moderately long hairlike setae on asperate area, and rather short, narrow, scalelike setae on the granulate-punctate area.

Elytra shining; striae not impressed, punctures of moderate size and depth, usually separated by a distance greater than their own diameters (irregular); interstriae as wide or wider than striae, their surface finely, not closely granulate-punctate, rather coarsely granulate near elytral base. Declivity steep, convex; strial and interstrial punctures reduced in size, and not as deep as on the disc. Elytral vestiture consisting of abundant, short, confused, semirecumbent, interstrial, scalelike setae; and longer, rather sparse, uniserial rows of scalelike bristles.

Male: Similar to the female.

Type Locality: Alta, Utah.

Hosts: Salix scouleriana, and *Salix* sp.

Distribution: Probably throughout the range of the host tree in the western United States and in Canada. Specimens from the following localities have been examined. *California:* Madera. *Colorado:* Fort Collins. *Idaho:* Minadoka National Forest. *South Dakota:* Black Hills. *Utah:* Alta, and Logan Canyon. *British Columbia:* Copper Mountain. *Quebec:* Laniel.

The type specimens of *P. utahensis* and *P. salicis* are in the U. S. National Museum.

Procryphalus mucronatus (Leconte)

(Figs. 48, 87)

Cryphalus mucronatus Leconte, 1879, U. S. Dept. Int., Geol. Geogr. Survey Bull. no. 5, p. 518; Schwarz, 1886, Ent. Amer., vol. 2, p. 42.

Procryphalus mucronatus, Hopkins, 1915, U. S. Dept. Agr., Rep. no. 99, p. 33; Chamberlin, 1939, The Bark and Timber Beetles of North America North of Mexico, p. 322.

Procryphalus idahoensis Hopkins, 1915, U. S. Dept. Agr., Rep. no. 99, p. 34; Chamberlin, 1939, The Bark and Timber Beetles of North America North of Mexico, p. 321.

Procryphalus populi Hopkins, 1915, U. S. Dept. Agr., Rep. no. 99, p. 34; Chamberlin, 1939, The Bark and Timber Beetles of North America North of Mexico, p. 321; Wood, 1951, Proc. Utah Acad. Sci., vol. 26, p. 128.

This species is closely allied to *P. utahensis,* but distinguished by the larger size, the more coarsely, closely punctured frons, the more strongly produced anterior pronotal margin with only six teeth, and the more coarsely, closely granulate-punctate elytral interspaces.

Female: Length 1.8-2.2 mm., 2.54 times as long as wide, body color black.

Frons slightly convex to indistinctly impressed, coarsely, closely, deeply punctured, weakly impressed above the epistoma, an indistinct median ridge extending from upper level of eyes to epistomal margin; pubescence consisting of inconspicuous, sparse, fine long hair. Eye elongate-oval, slightly wider above, entire. Antennal club longer than scape, about 1.62 times as long as wide, with two straight sutures on the anterior face, the first suture septate.

Pronotum about as long as wide; strongly produced on anteromedian margin and armed with six teeth, the third pair much smaller and more widely spaced, located at base of produced area; summit anterior to middle; asperate in front of and to sides of summit, the asperities rather small, abundant; posterolateral areas rather coarsely, strongly granulate-punctate; pubescence consisting of moderately long hairlike setae on asperate area, and rather short, narrow, scalelike setae on granulate-punctate area.

Elytra shining; striae not impressed, the punctures of moderate size, not always distinct or regularly spaced; interstriae about equal in width to striae, the surface coarsely, closely granulate-punctate. Declivity steep, convex; strial and interstrial punctures reduced in size and not as deep as on disc. Elytral vestiture consisting of abundant, short, confused, semirecumbent, interstrial, scalelike setae; and longer, rather sparse, uniserial rows of scalelike, interstrial bristles.

Male: Similar to the female.

Type locality: La Veta Pass, Colorado.

Host: Populus tremuloides.

Distribution: The high mountains of Colorado, Utah, eastern Nevada, and southern Idaho. Specimens from the following localities have been examined. *Colorado:* Gould, La Veta Pass, and

Tercio. *Idaho:* Beaver Canyon, and Franklin Basin. *Nevada:* Baker. *Utah:* Beaver, and Logan Canyon.

The type specimen of *Cryphalus mucronatus* is in the Museum of Comparative Zoology, those of *P. populi* and *P. idahoensis* are in the U. S. National Museum.

Ernopocerus Balachowsky

Ernopocerus Balachowsky, 1949, Faune de France 50, Coleopteres Scolytides, p. 211.

The genus *Ernopocerus* was recently established by Balachowsky to include *Ernoporus caucasicus* and *E. fagi* from Europe. One North American species, Hopkin's *Ernoporus kanawhae,* should also be added to *Ernopocerus.* Since Balachowsky did not designate a type for the genus the first species listed by him is here selected as the type species. If article 25c, paragraph 3 of the International Rules of Zoological Nomenclature, requiring designation of a type species after 1930, is upheld, the generic name *Ernopocerus* will date from the present publication rather than from 1949.

The genus *Ernopocerus* is more closely allied to *Procryphalus* than to other North American genera. It is distinguished from allied genera by the absence of a fine, raised, lateral line on the pronotum and only an indistinct basal line, the antennal funicle four-segmented, the club subcircular with the sutures indicated by three strongly procurved rows of setae, and the third tarsal segment cylindrical.

Frons convex, finely granulate, with scanty pubescence. Eye sinuate on anterior margin; finely granulate; about two times as long as wide. Antennal club subcircular with three strongly procurved, nonseptate sutures indicated by rows of setae; funicle four-segmented, the fourth segment only slightly wider than the second.

Pronotum about as wide as long; the finely raised lateral line absent, the basal line not clearly indicated; summit at middle; asperate in front of summit, the asperities rather large and quite numerous; anterior-median margin armed with two to four teeth.

Elytral striae distinct, the punctures rather small; interstriae rather coarsely punctured; declivity rather steep, convex; vestiture consisting of abundant, short, scalelike setae, and uniserial rows of longer, widely spaced, scalelike, interstrial bristles.

The sexes are similar, but separated by differences of the seventh and eighth abdominal terga.

Type species: Ernoporus caucasicus Lindemann, present designation.

Ernopocerus kanawhae (Hopkins)

Ernoporus kanawhae Hopkins, 1915, U. S. Dept. Agr., Rep. no. 99, p. 35; Blatchley and Leng, 1916, Rhynchophora of North Eastern America, p. 605; Chamberlin, 1939, The Bark and Timber Beetles of North America North of Mexico, p. 317.

This species is known only from the type specimen; it is closely allied to, but entirely distinct from *E. caucasicus* of Europe.

Female: Frons convex, finely granulate; pubescence consisting of rather short, moderately abundant hair. Eye sinuate on anterior margin; finely granulate. Antennal club large, subcircular in outline, with three strongly procurved sutures indicated by rows of setae; not septate.

Pronotum rather broadly rounded in front, armed with four small marginal teeth; summit near middle; anterior slope with numerous, rather small asperities; posterior area with widely spaced granulate punctures, the surface shining although not entirely smooth; pubescence hairlike in asperate area, short scales behind.

Elytra shining; striae not impressed, the punctures very small, distinct, not deep, spaced by about twice their own diameters (irregular); interstriae two to three times as wide as the striae, the punctures rather coarse, shallow, confused, subgranulate. Declivity rather steep, convex; striae obsolete. Elytral vestiture consisting of short, rather narrow, abundant scalelike setae; and uniserial rows of rather widely spaced, scalelike, interstrial bristles, each bristle about one and one-half times as long as wide, and about one and one-half times as long as the shorter, more abundant, interstrial scales.

Type locality: Kanawha Station, West Virginia.

Distribution: Known only from the unique type which was taken in flight.

The type specimen of *E. kanawhae* is in the U. S. National Museum.

Cryphalus Erichson

Cryphalus Erichson, 1836, Archiv. für Naturgesch., vol. 1, p. 61; Thomson, 1859, Skandanaviens Coleoptera Synoptiskt Bearbetade, p. 146; Eichhoff, 1864, Berlin Ent. Zeit., vol. 8, pp. 34, 45; Leconte, 1876, Proc. Amer. Phil. Soc., vol. 15, p. 361; Leconte and Horn, 1883, Coleoptera of North America, p. 518; Goz, 1885, Rev. d'Ent., vol. 4, p. 278; Bedel, 1888, Fauna Coleoptera du Bassin de la Seine, vol. 6, pp. 396, 397; Reitter, 1894, Verh. Naturf. Vereines Brünn, vol. 33, p. 69; Barbey, 1901, Les Scolytides de l'Europe Centrale, p. 69; Hagedorn, 1910, Coleopterorum Catalogus, pars 4, p. 40; Hagedorn, 1910, Genera Insectorum, fasc. 111, p. 84.

Trypophloeus Fairmaire, 1868, Faune Ent. France, vol. 4, p. 105; Klimesch, 1913, Ent. Blätt., vol. 9, p. 105; Reitter, 1913, Wien. Ent. Zeit., vol. 32, pp. 69-71; Klimesch, 1914, Ent. Blätt., vol. 10, p. 231; Hopkins, 1915, U. S.

Dept. Agr., Rep. no. 99, p. 36; Blatchley and Leng, 1916, Rhynchophora of North Eastern America, p. 605; Swaine, 1918, Dom. Can. Dept. Agr., Tech. Bull. 14, p. 90; Leng, 1920, Catalogue of the Coleoptera of America North of Mexico, p. 340; Peyerimhoff, 1935, Bull. Soc. Ent. France, vol. 40, pp. 194-195; Chamberlin, 1939, The Bark and Timber Beetles of North America North of Mexico, p. 322; Balachowsky, 1949, Faune de France 50, Coleopteres Scolytides, p. 213.

Glyptoderus Eichhoff, 1879, Ratio . . . Tomicinorum, p. 137; Eichhoff, 1881, Europäischen Borkenkäfer, p. 187.

Erichson (1836) described the genus *Cryphalus* to include *Apate tiliae* Panzer, *A. fagi* Fabricius, and *Bostrichus asperatus* Gyllenhal. Thomson (1859) designated *B. asperatus* as the type of the genus *Cryphalus* and assigned *A. tiliae* to his monobasic subgenus *Ernoporus.* Later, he (1865) also transferred *A. fagi* to *Ernoporus,* leaving *B. asperatus* as the only representative of the genus *Cryphalus* as it was originally established. The monobasic genus *Trypophloeus* was described by Fairmaire (1868) to include *Bostrichus binodulus* Ratzeburg. It was later established by Eichhoff (1881) that *B. asperatus* and *B. binodulus* were synonymous. Subsequent authors, not recognizing *B. asperatus* as the type of *Cryphalus,* retained the name *Trypophloeus* since the *asperatus* group of species was genericly distinct from the then current concept of the genus *Cryphalus.* Eichhoff (1879), unaware of Fairmaire's genus *Trypophloeus,* erected *Glyptoderus* with *Bostrichus binodulus* Ratzeburg as the type (assigned by Hopkins in 1914).

Since *Cryphalus* Erichson (1836), *Trypophloeus* Fairmaire (1868), and *Glyptoderus* Eichhoff (1879) all have *Bostrichus asperatus* Gyllenhal (= *Bostrichus binodulus* Ratzeburg) as the type species, it is quite obvious that they are synonymous, and that the name Cryphalus has priority. The genus formerly designated by the name *Cryphalus* must now take the name *Taenioglyptes* Bedel (1888) with *Bostrichus piceae* Ratzeburg as the type species. It is most unfortunate that temporary confusion must result from changing names of these large and important genera; however, an orderly system of classification can never be established by ignoring such glaring nomenclatorial descrepancies as these.

The genus *Cryphalus* is more closely allied to *Taenioglyptes* than to other North American genera. It is distinguished from allied genera by the absence of a distinctly raised lateral line on the pronotum (the basal line is present); the antennal funicle five-segmented; the club slender, distally pointed, with three straight sutures indicated by rows of setae; and the third tarsal segments cylindrical or laterally compressed.

Frons weakly convex to planoconcave, punctured, with scanty pubescence. Eye elongate-ovate, about two to two and one-fifth times as long as wide, wider above; finely granulate; entire or with two or three facets absent suggesting an emargination. Antennal club elongate, tapered at both ends, indistinctly constricted at the first and second sutures, three straight sutures indicated by rows of setae; funicle five-segmented, the fifth segment much wider than the second.

Pronotum wider than long; a fine, elevated, basal line present, the lateral lines absent; summit slightly behind middle; asperate anterior to summit, the asperities rather large, broad, and numerous; anterior-median margin slightly produced and armed with several teeth. Fore tibiae broadened distally, with about eight teeth on outer margin of distal one third. Hind tibiae with about six teeth on distal one third. The third tarsal segments slightly compressed laterally.

Elytral striae distinct or not, the punctures variable; interstriae punctured, usually with a single row of granules in addition; declivity rather steep, often with a broad impression between the first and fourth interstriae, the posterior extremity of the fourth interstriae usually prominent, often bearing granules of variable size; vestiture consisting of abundant short scale- or hairlike setae, and uniserial rows of rather widely spaced, interstrial, scale- or hairlike bristles.

The sexes are similar, although there may be a tendency for the males to be slightly smaller. They are easily separated by differences of the seventh and eighth abdominal terga.

Type Species: Bostrichus asperatus Gyllenhal, subsequent designation (Thomson, 1859).

KEY TO THE SPECIES OF CRYPHALUS

1. Strial punctures impressed, at least on basal one fourth, their greatest diameter about equal in width to adjacent interstriae; vestiture hairlike at least on anterior one half of elytra; declivital bristles distinctly longer than one half of distance between rows of bristles 2

Strial puntures obscure, much narrower than interstriae; elytral vestiture at least on posterior three fourths scalelike; declivital bristles not longer than one half the distance between rows of bristles 3

2. Strial punctures coarse, deep, at least on basal one half; punctures on posterolateral areas of pronotum rather large, deep, and close; scalelike pubescence confined to declivity .... *nitidus*

Strial punctures greatly reduced except on basal one fourth; punctures on posterolateral areas of pronotum rather small, shallow, not as close; scalelike pubescence covering posterior half of elytra . . . . *salicis*

3. Posterior extremity of fourth interspace either smooth, or with minute rounded granules; the short, abundant elytral scales broad, rounded distally; frons usually not subconcavely impressed . . . *populi*

Posterior extremity of fourth interspace with a row of one to five small, slender teeth, each at least twice as long as its basal width; the short, abundant elytral scales acuminate; frons usually subconcavely impressed . . . . *thatcheri*

Cryphalus nitidus (Swaine)

(Figs. 43, 88)

Trypophloeus nitidus Swaine, 1912, Can. Ent., vol. 44, p. 349; Blatchley and Leng, 1916, Rhynchophora of North Eastern America, p. 605; Swaine, 1918, Dom. Can. Dept. Agr., Tech. Bull. 14, p. 90; Dodge, 1938, Minn. Agr. Exp. Sta., Tech. Bull. 132, p. 39; Chamberlin, 1939, The Bark and Timber Beetles of North America North of Mexico, p. 323.

Trypophloeus punctipennis Hopkins, 1915, U. S. Dept. Agr., Rep. no. 99, p. 37; Chamberlin, 1939, The Bark and Timber Beetles of North America North of Mexico, p. 323; Wood, 1951, Proc. Utah Acad. Sci., vol. 26, p. 128.

The coarse strial punctures extending at least two thirds of the distance from the elytral base to the declivity, and the absence of scalelike pubescence, except to a limited extent on the declivity, distinguish this species from other North American representatives of this genus.

Female: Length 1.6-2.0 mm., 2.45 times as long as wide, body color black.

Frons convex, with a Y-shaped (variable) impression beginning above upper level of eyes, branching above the epistoma and continuing to edge of antennal sockets; surface coarsely reticulate above upper level of eyes, coarsely, shallowly, closely punctured below; pubescence consisting of inconspicuous, fine, sparse hair of medium length. Eye elongate-ovate, wider above, about 2.2 times as long as wide, finely granulate; entire or with two or three facets missing suggesting an emargination. Antennal club longer than scape, about 1.69 times as long as wide, with three straight sutures indicated by rows of setae.

Pronotum 0.94 times as long as wide; anterior margin slightly produced, with four to eight contiguous or subcontiguous teeth, the lateral ones reduced in size; summit slightly behind middle; asperate in front of summit, the asperities rather large, abundant; posterior and lateral areas shining, the punctures rather close, coarse, quite deep; pubescence consisting of rather short, fine, erect hair, slightly longer in the asperate area.

Elytra shining; striae not impressed, the punctures rather coarse and deeply impressed on anterior two thirds of disc, usually becoming smaller and shallow near declivity; interstriae (anteriorly) about as wide as striae, becoming crenulate basally on disc, the punctures fine, shallow, confused, rather abundant, subgranulate anteriorly. Declivity rather steep, convex; striae weakly impressed, the punctures reduced; interstriae each with a uniserial row of small, rather widely spaced granules. Elytral vestiture on disc and sides consisting of rather abundant, short, hairlike, strial and interstrial setae; and uniserial rows of longer hairlike bristles; on declivity both short and long setae become stout and more nearly scalelike.

Male: Similar to the female.

Type locality: Weymouth, Nova Scotia.

Hosts: Alnus crispa, A. incana, A. rhombifolia, Salix scouleriana, and S. *species.*

Distribution: This species probably occurs throughout the northern coniferous forests wherever its hosts are found. Specimens from the following localities have been examined. *Idaho:* Coeur d'Alene. *Minnesota:* Lake County. *Utah:* Alta, and Logan Canyon. *Nova Scotia:* Weymouth. *Quebec:* Laniel.

The type specimen of *Trypophloeus nitidus* could not be located at this time, that of *T. punctipennis* is in the U. S. National Museum.

Cryphalus salicis (Hopkins)

(Figs. 44, 89)

Trypophloeus salicis Hopkins, 1915, U. S. Dept. Agr., Rep. no. 99, p. 36; Chamberlin, 1939, The Bark and Timber Beetles of North America North of Mexico, p. 323.

Trypophloeus concentralis Hopkins, 1915, U. S. Dept. Agr., Rep. no. 99, p. 36; Chamberlin, 1939, The Bark and Timber Beetles of North America North of Mexico, p. 324.

This species is closely allied to *C. nitidus,* but differs in having the scalelike pubescence of the elytra covering the posterior one half including part of the disc, the strial punctures coarse and impressed on less than the anterior one third of the elytra, and the punctures on the posterolateral areas of the pronotum smaller, and shallow.

Female: Length 1.5-1.7 mm., 2.50 times as long as wide, body color dark brown.

Frons flattened on a rather broad area, subconcave in some of the Washington specimens; rather weakly impressed above the epistoma, with a short median prominence reaching the epistoma; surface coarsely, closely, shallowly punctured at sides and above, indistinctly punctured toward the center; pubescence consisting of inconspicuous, fine, sparse hair of medium length. Eye elongate-ovate, wider above, about 2.2 times as long as wide; finely granulate; entire or with two or three facets missing suggesting an emargination. Antennal club longer than scape, about 1.70 times as long as wide, with three straight sutures indicated by rows of setae.

Pronotum 0.92 times as long as wide; anterior margin very slightly produced, with six subcontiguous teeth (rarely an additional pair of granules), the lateral pair reduced in size; summit slightly behind middle; asperate in front of summit, the asperities rather large, abundant; posterior and lateral areas usually reticulate, and with small rather close, shallow punctures; pubescence consisting of rather short, fine, erect hair, slightly longer in the asperate area.

Elytra shining; striae not impressed, the punctures rather coarse and quite deep on basal one fourth of disc, less than one-half as large on posterior three fourths; interstriae on basal one fourth only slightly wider than striae, much wider posteriorly, usually subcrenulate toward the base, the punctures about as large as those of striae on posterior three fourths of disc, confused; a uniserial row of widely spaced, fine granules on each interspace, each granule bearing an interstrial bristle. Declivity moderately steep, with a broad, shallow impression between the first and fourth interstriae; striae obscure; interstriae each with a row of fine granules, the posterior extremity of the fourth slightly elevated and bearing one to four larger, sharply pointed toothlike granules. Elytral vestiture consisting of numerous, short, semirecumbent strial and interstrial setae; and uniserial rows of longer, erect bristles; both types of setae hairlike on the anterior half of elytra, scalelike on the posterior half, particularly on the declivity.

Male: Similar to the female.

Type locality: Del Monte, California.

Hosts: Alnus sp., and *Salix* sp.

Distribution: Central California to Washington. Specimens from the following localities have been examined. *California:* Belmont, and Del Monte. *Washington:* Easton, and Fort Flagler.

The type specimens of *Trypophloeus salicis* and *T. concentralis* are in the U. S. National Museum.

Cryphalus populi (Hopkins)

(Figs. 8, 9, 26, 34, 45, 91)

Trypophloeus populi Hopkins, U. S. Dept. Agr., Rep. no. 99, p. 37; Chamberlin, 1939, The Bark and Timber Beetles of North America North of Mexico, p. 323; Wood, 1951, Proc. Utah Acad. Sci., vol. 26, p. 128.

This species is very closely related to *C. thatcheri,* differing only by the absence of small, slender teeth at the posterior end of the fourth elytral interspace, the short abundant elytral scales much wider and rounded distally, and the frons usually not as deeply impressed. It is entirely possible that the two forms are only subspecifically distinct; additional information of their biology and distribution are necessary to determine this. The two species differ from other North American representatives of the genus by the presence of scalelike pubescence covering the elytra from the base to the posterior margin, and the strial punctures obscure throughout their length.

Female: Length 1.7-2.1 mm., 2.30 times as long as wide, body color black.

Frons variable, flattened or weakly convex, rather weakly impressed above the epistoma, occasionally with a more or less distinct median impression or elevation; surface coarsely reticulate above the eyes, closely, coarsely rather deeply punctured below; pubescence consisting of inconspicuous, fine, sparse hair of medium length. Eye elongate-ovate, wider above, two times as long as wide; finely granulate; entire or with two or three facets missing suggesting an emargination. Antennal club longer than scape, about 1.87 times as long as wide, with three straight sutures indicated by rows of setae.

Pronotum 0.88 times as long as wide; anterior margin slightly produced, with four rather large, subcontiguous teeth, the median pair larger, often with two additional smaller lateral granules; summit slightly behind middle; asperate in front of summit, the asperities rather large, abundant; posterior and lateral areas shining, the punctures rather close, coarse, quite deep; pubescence consisting of rather short, fine, semierect hair, some of these setae stout and almost scalelike on the basal portion.

Elytra shining; striae not impressed, the punctures reduced in size, shallow, usually obscure; interstriae with numerous, fine, confused, shallow punctures about equal in size to those of striae; usually bearing a uniserial row of widely spaced, fine granules, each granule bearing an interstrial bristle. Declivity rather steep, convex except for a slight impression between the first and fourth interstriae; striae usually obscure; interstriae each with a row of fine granules, the posterior extremity of the fourth very slightly elevated, the granules scarcely larger than on other interspaces. Elytral vestiture consisting of numerous, short, semirecumbent, interstrial scalelike setae; and uniserial rows of rather widely spaced, scalelike bristles, each bristle about two times as long as the shorter scales; both types of setae covering the elytra from the base to the posterior margin.

Male: Similar to the female.

Type locality: Williams, Arizona.

Hosts: Populus acuminata, P. angustifolia, P. tremuloides, and *P. trichocarpa.*

Distribution: Eastern Nevada to Colorado, northern Arizona to Saskatchewan and eastward in Canada to New Brunswick. Specimens from the following localities have been examined. *Arizona:* Williams. *Colorado:* Bellvue. *Nevada:* Baker. *Utah:* Logan, and Logan Dry Canyon. *Manitoba:* Aweme. *New Brunswick:* Fredericton. *Saskatchewan:* Indian Head.

The type specimen of *Trypophloeus populi* is in the U. S. National Museum.

Cryphalus thatcheri, new species

(Fig. 90)

This species is very closely allied to *C. populi,* but differs by the presence of a row of one to five small slender teeth at the posterior end of the fourth elytral interspace, each tooth at least twice as long as its basal width; the short, abundant elytral scales acuminate; and the frons usually subconcavely impressed. Additional knowledge of its distribution and biology may prove it to be only a subspecies of *C. populi.*

Female: Length 1.5-1.9 mm., 2.26 times as long as wide, body color black.

Frons flattened over a broad area, subconcave in most specimens; surface coarsely, shallowly, closely punctured, usually longitudinally subaciculate; pubescence consisting of inconspicuous, fine, sparse hair of medium length. Eye elongate-ovate, wider above, two times as long as wide; finely granulate; entire or with two or three facets missing suggesting an emargination. Antennal club longer than scape, about 2.2 times as long as wide, with three straight sutures indicated by rows of setae.

Pronotum 0.88 times as long as wide; anterior margin slightly produced and armed with four rather large, subcontiguous teeth (similar to *C. populi*), the median pair larger, and often with one or two smaller lateral granules; summit slightly behind middle; asperate in front of summit, the asperities rather large, abundant; posterior and lateral areas shining, the punctures rather large, close, and quite deep, granulate-punctate behind summit; pubescence consisting of rather short, fine, semierect hair.

Elytra shining; striae not impressed, the punctures reduced in size, shallow, usually obscure; interstriae with numerous, fine, confused, shallow punctures about equal in size to those of the striae, each usually bearing a single uniserial row of widely spaced, fine granules, each granule bearing an interspacial bristle. Declivity rather steep; convex except for a broad, indistinct impression between the first and fourth interstriae; striae usually obscure; interstriae each with a row of small granules; the posterior extremity of the fourth interspace slightly elevated and bearing a row of one to five small, slender, sharply pointed toothlike granules, each tooth at least twice as long as its basal width. Elytral vestiture consisting of numerous, short, semirecumbent, scalelike, interstrial setae, each scale more or less acuminate; and uniserial rows of rather widely spaced, scalelike bristles, each with an interspacial granule at its base, each bristle about two to three times as long as the shorter scales; both types becoming more nearly hairlike near the elytral base.

Male: Similar to the female. Since the smallest specimens are males and the largest ones females, the average size of the male may be slightly smaller. Because of the difficulty of determining the sex and the small number of specimens at hand this observation cannot be fully verified.

Type Locality: Two miles northwest of Blue Lake, Lassen County, California.

Host: Populus tremuloides.

Distribution: Known from the Warner Mountains of northern California south to Pasadena. The female holotype, male allotype, and 35 paratypes were collected July 19, 1947 by T. O. Thatcher. In addition 26 paratypes were obtained from Warner Mountains, Modoc County, July 10, 1910 (collector unknown); Sonora Pass, Aug. 4, by J. N. Knull; and Pasadena.

The holotype, allotype, and paratypes are in the Snow Entomological Collections. Additional paratypes are in the collections of the U. S. National Museum, Canadian National Collection, California Academy of Sciences Museum, J. N. Knull, T. O. Thatcher, and the author.

Cryphalus striatulus Mannerheim

Cryphalus striatulus Mannerheim, 1853, Bull. Mosc., p. 253; Leconte, 1876, Proc. Amer. Phil. Soc., vol. 15, p. 362; Eichhoff, 1879, Ratio . . . Tomicinorum, p. 147; Swaine, 1909, N. Y. State Mus., Bull. 134, p. 93.

Procryphalus striatulus, Hopkins, 1915, U. S. Dept. Agr., Rep. no. 99, p. 33; Swaine, 1914, Dom. Can. Dept. Agr., Tech. Bull. 14, p. 90; Chamberlin, 1939, The Bark and Timber Beetles of North America North of Mexico, pp. 315, 321.

The type is evidently lost. The brief description, however, suggests it may either be very similar to or perhaps synonymous with *Cryphalus nitidus*. Since specimens from the type locality are not available, the status of this species will not be altered at this time. It is rather doubtful that it should be assigned to *Procryphalus* as was done by Hopkins (1915, p. 33).

Cryphalomorphus Schaufuss

Lepicerus Eichhoff, 1879 (not Motschulsky, 1855), Ratio . . . Tomicinorum, p. 476; Hagedorn, 1910, Coleopterorum Catalogus, pars 4, p. 69; Hagedorn, 1910, Genera Insectorum, fasc. 111, p. 90; Hopkins, 1915, U. S. Dept. Agr., Rep. no. 99, p. 8.

Cryphalomorphus Schaufuss, 1891, Tijdschr. Ent., vol. 34, p. 12; Hagedorn, 1910, Coleopterorum Catalogus, pars 4, p. 46; Hagedorn, 1910, Genera Insectorum, fasc. 111, p. 83; Hopkins, 1915, U. S. Dept. Agr., Rep. no. 99, p. 7, Pl. II, fig. 3; Schedl, 1952, Dusenia, vol. 3, p. 344.

Letznerella Reitter, 1913, Wien. Ent. Zeit., Jahrg. 32, p. 68; Swaine, 1918, Dom. Can. Dept. Agr., Tech. Bull. 14, p. 90; Leng, 1920, Catalogue of the Coleoptera of America North of Mexico, p. 340; Chamberlin, 1939, The Bark and Timber Beetles of North America North of Mexico, p. 316; Schedl, 1940, An. Esc. Nac. Cienc. Biol. (Mexico), vol. 1, p. 341.

Ernoporides Hopkins, 1915, U. S. Dept. Agr., Rep. no. 99, p. 34; Blatchley and Leng, 1916, Rhynchophora of North Eastern America, p. 604; Leng, 1920, Catalogue of the Coleoptera of America North of Mexico, p. 340; Chamberlin, 1939, The Bark and Timber Beetles of North America North of Mexico, p. 315.

Lepicerinus Hinton, 1936, An. Mag. Nat. Hist., Series 10, vol. 17, p. 472; Schedl, 1940, Mitt. Münch. Ent. Ges., vol. 30, p. 587.

Neocryphalus Eggers, 1922, Ent. Bl., vol. 18, p. 169.

Eichhoff described the genus *Lepicerus* in 1879, with *L. aspericollis* from Burma as the type species. In 1936, Hinton found the name *Lepicerus* to be preoccupied and proposed the new name *Lepicerinus*. Meanwhile, Schaufuss (1891) had described *Cryphalomorphus* with *C. communis*, from Madagascar, as the type species; Reitter (1913) had described *Letznerella* with *Bostrichus jalappae* Letzner, from Brazil, as the type species; and Hopkins (1915) had described *Ernoporides* with *E. floridensis*, from Florida, as the type species. Following a study of their type species it was established (1940) by Schedl that *Cryphalomorphus*, *Letznerella*, *Ernoporides*, and *Lepicerinus* were synonymous and he used the name *Lepicerinus*. However, if these genera are synonymous the name *Cryphalomorphus* has priority and should be employed to designate this genus. Schedl (1952b, p. 344) later recognized this and made the correction.

The genus *Cryphalomorphus* is perhaps more closely allied to *Ernopocerus* than to other North American genera. It differs conspicuously from *Ernopocerus* by not having the antennal club segmentally marked by rows of setae; the first suture is indicated only by a strongly oblique septum on one side; the marginal teeth of the pronotum are absent, submarginal teeth sometimes are present; and the posterior margins of the elytra ascend only slightly. The sexes are similar.

Frons convex, broad, punctured, with scanty pubescence. Eye entire; finely granulate. Antennal club rather large, subcircular to oval, not constricted or marked by sutures except for a septum in one half of the strongly oblique first suture; funicle four-segmented, the second segment about as wide as the fourth.

Pronotum about as long as wide; basal margin and posterior one third of lateral margin with a fine elevated line; asperate in front of summit; teeth usually absent from anterior margin. Fore tibiae with several teeth on distal one half of outer margin. Hind tibiae with five teeth on distal one third.

Elytral striae distinct or not, the punctures variable; interstriae with punctures and granules; declivity rather steep, convex, without special elevations or impressions; vestiture consisting of abundant, short, semierect, scale- and hairlike strial and interstrial setae, and uniserial rows of erect, long, interstrial, scalelike bristles.

Type Species: Cryphalomorphus communis Schaufuss, monobasic.

KEY TO THE SPECIES OF CRYPHALOMORPHUS

1. Strial punctures rather large, much larger than interstrial punctures; lateral areas of pronotum rather coarsely punctured; larger, 1.6-1.8 mm. .... *jalappae*

   Strial punctures only slightly larger than interstrial punctures; lateral areas of pronotum very finely punctured; smaller, 1.25-1.55 mm. .... *floridensis*

Cryphalomorphus jalappae (Letzner)

This exotic species is occasionally obtained from *Jallapa* root imported from Mexico. It differs from *C. floridensis* by the more coarsely punctured lateral areas of the pronotum, the much larger strial punctures, and the larger size (1.6-1.8 mm.).

Cryphalomorphus floridensis (Hopkins)

(Figs. 10, 11, 27, 35, 49, 92)

Ernoporides floridensis Hopkins, 1915, U. S. Dept. Agr., Rep. no. 99, p. 34; Blatchley and Leng, 1916, Rhynchophora of North Eastern America, p. 604; Chamberlin, 1939, The Bark and Timber Beetles of North America North of Mexico, p. 315.

Lepicerinus floridensis, Schedl, 1940, Mitt. Münch. Ent. Ges., vol. 30, p. 588.

This is the only representative of this genus known to breed in the United States. It is not likely to be confused with native species of allied genera.

Female: Length 1.25-1.55 mm., 2.6 times as long as wide, body color dark brown.

Frons convex, with an indistinct, median, longitudinal elevation, and a weak transverse impression above the epistoma; surface with coarse, close, deep punctures above; punctures reduced in size, and shallow in the transverse impression; reticulate above frons. Eye entire; finely granulate. Antennal club slightly longer than scape, 1.44 times as long as wide, one-half of the first suture septate, strongly oblique; the other sutures not evident.

Pronotum equal in length and width; usually with two submarginal teeth, their position variable; summit at middle; asperate in front of summit, the asperities rather small, numerous; posterolateral areas finely, rather closely punctured, sparsely granulate behind summit; pubescence consisting of rather short, semirecumbent, hairlike setae, intermixed on posterior half with equally long scalelike setae.

Elytra shining; striae not impressed, the punctures very fine, rather deep, separated by a distance greater than their own diameters; interstriae about three times as wide as striae, the punctures numerous, confused, slightly smaller than strial punctures, each giving rise to a short hair- or scalelike seta, in addition uniserial rows of widely spaced granules give rise to scalelike bristles. Declivity rather steep, convex; strial puntures slightly larger, and the interstrial granules closer than on disc. Elytral vestiture consisting of short, rather abundant, semierect strial and interstrial hair- and scalelike setae; and uniserial rows of long, erect, rather narrow, scalelike interstrial bristles.

Male: The sexes are similar, but the average size of the male is slightly smaller than that of the female.

Type locality: Biscayne, Florida.

Hosts: Candiosperma holacacobium, and *Ipomoea pes-caprae.*

Distribution: Specimens from Plantation Key and Sugar Loaf Key, Florida, have been examined.

The type specimen of *Ernoporides floridensis* is in the U. S. National Museum.

Hypocryphalus Hopkins

Hypocryphalus Hopkins, 1915, U. S. Dept. Agr., Rep. no. 99, p. 41; Beeson, 1938, Fed. Malay States Mus. Jour., vol. 18, p. 288; Schedl, 1938, Trans. Roy. Soc. South Australia, vol. 62, p. 48.
Dacryphalus Hopkins, 1915, U. S. Dept. Agr., Rep. no. 99, p. 42.

This genus is allied to *Taenioglyptes*, but has the antennal funicle five-segmented, the sutures of the antennal club procurved, the tarsi more slender, with the third segment not as broad, and the tibiae more slender. It is represented in North America by only one species recently introduced into southern Florida.

Frons broad, convex above, slightly flattened below; epistomal margin with a short, ventrally directed brush. Eye emarginate; finely granulate. Antennal funicle five-segmented in both sexes; club large, subcircular, with three procurved sutures marked only by rows of setae.

Pronotum slightly wider than long; basal and posterior one third of lateral margin with a fine elevated line; asperate in front of summit, with about four to eight teeth on anterior margin. Fore tibiae rather slender, with six teeth on distal two fifths of outer margin. Hind tibiae slender, with three or four teeth on distal margin.

Elytral striae impressed or not, the punctures obscure; interstriae rather wide, densely clothed with short, recumbent hairlike setae, and with uniserial rows of erect bristles; declivity not steep, convex.

Sexes similar in general appearance, the posterior margin of the fifth abdominal segment more broadly rounded (subtruncate) in the male.

Type Species: Hypocryphalus rotundus Hopkins, original designation.

Hypocryphalus mangiferae (Stebbing)

(Figs. 14, 15, 29, 37, 53)

Cryphalus mangiferae Stebbing, 1914, Indian Forest Insects, p. 542; Schedl, 1942, Tijdschr. Ent., vol. 85, p. 2.
Dacryphalus mangiferae, Hopkins, 1927, Bull. Ent. Research, vol. 18, p. 28.
Hypocryphalus mangiferae, Beeson, 1929, Insects of Samoa, vol. 4, p. 226; Eggers, 1931, Wien. Ent. Zeit., vol. 47, p. 185; Beeson, 1938, Fed. Malay States Mus. Jour., vol. 18, p. 288; Beeson, 1940, B. P. Bishop Mus., Occas. Papers, vol. 15, p. 198; Schedl, 1942, Kolonialforst. Mitt., vol. 5, p. 176; Blackwelder, 1948, Fifth Supplement to the Leng Catalogue of Coleoptera

of America north of Mexico, p. 49; Swezey, 1949, Proc. Hawaiian Ent. Soc., vol. 13, p. 445.

Hypocryphalus mangiferae Eggers, 1928 (not Stebbing, 1914), Inst. Biol. (Sao Paulo) Arquivos, vol. 1, p. 85; Costa Lima, 1929, Mem. Inst. Oswaldo Cruz, Suppl. No. 8, p. 110.

Female: Length 1.6-1.9 mm., about 2.20 times as long as wide, body color dark yellowish-brown.

Frons broad, convex above, more or less flattened below; surface finely aciculate, reticulate above frons; evidently punctured only at sides and above; pubescence consisting of very fine, inconspicuous hair of medium length, a more conspicuous, short, ventrally directed brush on epistomal margin. Eye narrowly, rather deeply emarginate; finely granulate. Antennal club large, subcircular, slightly longer than scape; not septate, with three procurved sutures indicated by rows of setae.

Pronotum about 0.93 times as long as wide; anterior margin bearing four (rarely three or five) teeth of moderate size, the median pair slightly larger, closely placed, the lateral ones separated by a distance at least equal to the basal width of one tooth; summit rather indefinite, near middle; asperate in front of summit, the asperate area closely, finely punctured; posterior and lateral areas uniformly, closely, finely granulate; pubescence consisting of abundant, rather short, fine, recumbent hair, and a few longer erect bristles.

Elytra dull, not shining; striae impressed, the punctures obscure, not impressed; interstriae two to three times as wide as striae, covered with closely placed, minute, confused granules, intermixed with a few minute, shallow punctures; each granule bearing a seta. Declivity convex, not steep. Elytral vestiture consisting of abundant, short, coarse, recumbent interstrial and strial hair; and uniserial rows of long, slender, hairlike interstrial bristles.

Male: The posterior margin of fifth abdominal segment more broadly rounded than in female, otherwise the sexes are similar.

Type locality: India.

Host: Mangifera indica (Mango).

Distribution: Most areas of the world where Mangoes are grown. Specimens from the following localities have been examined. *Florida:* Perrine, and Princeton. *Brazil:* Eggers' type (exact locality?). *Honduras:* LaCeiba.

The type specimen of *H. mangiferae* Eggers is in the U. S. National Museum.

Taenioglyptes Bedel

Taenioglyptes Bedel, 1888, Ann. Soc. Ent. France, Hors Serie, vol. 6, p. 398; Reitter, 1894, Verh. Naturf. Vereines Brünn, vol. 33, p. 70; Hagedorn, 1910, Coleopterorum Catalogus, pars. 4, p. 40.

Cryphalus, Eichhoff, 1879, Ratio . . . Tomicinorum, p. 121; Eichhoff, 1881, Europäischen Borkenkäfer, p. 172; Reitter, 1894; Verh. Naturf. Vereines Brünn, vol. 33, p. 69; Hagedorn, 1910, Coleopterorum Catalogus, pars. 4, p. 40; Hagedorn, 1910, Genera Insectorum, fasc. 111, p. 84; Hopkins, 1915, U. S. Dept. Agr., Tech. Bull. 17, p. 221; Hopkins, 1915, U. S. Dept. Agr., Rep. no. 99, p. 39; Blatchley and Leng, 1916, Rhynchophora of North Eastern America, p. 605; Chamberlin, 1918, Ore. Agr. Exp. Sta., Bull. 147, p. 13; Swaine, 1918, Dom. Can. Dept. Agr., Tech. Bull. 14, p. 87; Leng, 1920, Catalogue of the Coleoptera of America North of Mexico, p. 340; Peyerimhoff, 1935, Bull. Soc. Ent. France, vol. 40, p. 194; Chamberlin, 1939, The Bark and Timber Beetles of North America North of Mexico, p. 311; Balachowsky, 1949, Faune de France 50, Coleopteres Scolytides, p. 205.

The name *Taenioglyptes* was proposed in 1888 by Bedel as a subgenus of *Cryphalus.* Since that time it has either been ignored (American writers), or used as a synonym of *Cryphalus.* Reitter (1894) mentioned the name *Taenioglyptes* as a subgenus of *Cryphalus,* but did not recognize a subgenus *Cryphalus* and included the type species, *Bostrichus asperatus* Gyllenhal, in the subgenus *Taenioglyptes.* Hagedorn (1910a) employed Reitter's usage, but transferred the type species to what he recognized as the subgenus *Trypophloeus;* later Hagedorn (1910b) placed *Taenioglyptes* as a synonym of *Cryphalus.*

Since 1910, this genus has been recognized as *Cryphalus* even though the type species had been transferred to another genus. If the law of priority is to be followed, the oldest generic or subgeneric name applying to the species remaining must be recognized, that name is *Taenioglyptes* Bedel, with *Bostrichus piceae* Ratzeburg as the type species.

The genus *Taenioglyptes* is more closely allied to *Cryphalus* and *Hypocryphalus* than to other North American genera. It is readily distinguished by the following combination of characters: antennal funicle four-segmented; the club rather large, with three recurved sutures on the anterior face indicated by rows of setae; eye emarginate; pronotal summit on the basal one third; and the third tarsal segments rather broad and emarginate.

Frons convex, pubescence scanty. Eye emarginate, finely granulate. Antennal club rather large, oval, slightly constricted at each of the three non-septate recurved sutures; funicle four-segmented.

Pronotum wider than long; basal margin and posterior one third of lateral margin with a fine elevated line; asperate in front of summit, the summit on posterior one third; about three to eight teeth on the anterior margin; vestiture hairlike. Fore tibiae with five to nine slender teeth on distal one third; hind tibiae with four to seven slender teeth on distal one fourth. The third tarsal segments broad and emarginate.

Elytral striae usually distinct, the punctures small; interstriae rather wide, with numerous, confused punctures, occasionally subgranulate; declivity rather steep, convex, without special elevations or impressions. Vestiture consisting of short, inconspicuous, hairlike, strial setae; abundant, short, semierect, scalelike, interstrial setae; and uniserial rows of rather widely spaced, long, hairlike interstrial setae.

The sexes are similar, but easily separated by examination of the terga of the eighth and ninth abdominal segments.

Type Species: Bostrichus piceae Ratzeburg, subsequent designation (Hopkins, 1914).

KEY TO THE SPECIES OF TAENIOGLYPTES

1. Elytral declivity with widely spaced, uniserial rows of interstrial hairlike bristles, each bristle at least one half as long as distance between rows of bristles 2

   Interstrial bristles on declivity inconspicuous or absent, much shorter than one half distance between rows of bristles 3

2. Declivital bristles distinctly longer than distance between rows of bristles; British Columbia to California . . . . . . *pubescens*

   Declivital bristles one half as long as distance between rows of bristles . . . . . . *rubentis*

3. Strial punctures obsolete; posterior-lateral areas of pronotum granulate . . . . . . *fraseri*

   Strial punctures distinctly impressed; posterolateral areas of pronotum granulate-punctate 4

4. Posterolateral angles and base of pronotum punctate, the punctures larger and more widely separated, usually with a few granules intermixed; average body size larger; a few long declivital bristles nearly always present . . . . . . *ruficollis coloradensis*

   Posterolateral angles and usually the base of pronotum granulate, or at least granulate-punctate; average body size smaller; never with long declivital bristles 5

5. Posterolateral areas of pronotum with punctures more distinct, less granulate; striae more prominent, the punctures deeper and slightly larger; interspaces less rugose . . . . . . *ruficollis amabilis*

   Posterolateral areas of pronotum closely granulate-punctate; striae less prominent, the punctures usually not as deep; interstriae rugose . . . . . . *ruficollis ruficollis*

Taenioglyptes pubescens (Hopkins)

(Figs. 12, 13, 28, 36, 41, 42)

Cryphalus pubescens Hopkins, 1915, U. S. Dept. Agr., Rep. no. 99, p. 40; Swaine, 1918, Dom. Can. Dept. Agr., Tech. Bull. 14, p. 87; Chamberlin, 1939, The Bark and Timber Beetles of North America North of Mexico, p. 314; Patterson and Hatch, 1945, Univ. Wash. Publ. Biol., vol. 10, p. 152.

Cryphalus subconcentralis Hopkins, 1915, U. S. Dept. Agr., Rep. no. 99, p. 40; Swaine, 1918, Dom. Can. Dept. Agr., Tech. Bull. 14, p. 88; Chamberlin, 1917, Can. Ent., vol. 49, p. 322; Hopping, 1922, Can. Ent., vol. 54, p. 131; Chamberlin, 1939, The Bark and Timber Beetles of North America North of Mexico, p. 313.

This species is more closely allied to *T. piceae* of Europe than to other Nearctic species. It differs from other North American representatives of the genus by the very long interstrial hairlike bristles which are longer than the distance between rows of bristles; and the smoother, usually more finely punctured posterolateral areas of the pronotum. It differs from *T. piceae* by the more coarsely punctured posterolateral areas of the pronotum; and the presence of distinctly larger median teeth on the anterior margin of the pronotum.

Female: Length 1.6-1.9 mm., 2.38 times as long as wide, body color brown.

Frons weakly convex, with a short, often indistinct, median, longitudinal elevation above the epistoma; surface coarsely, shallowly, rather closely punctured, rather coarsely reticulate over a larger area; pubescence consisting of inconspicuous, sparse, fine hair of medium length, and a more conspicuous ventrally directed epistomal brush. Eye broadly, rather deeply emarginate; finely granulate. Antennal club longer than the scape, 1.37 times as long as wide, with three recurved sutures on the anterior face marked by rows of setae.

Pronotum 0.83 times as long as wide; anterior margin rather narrowly rounded, bearing four to eight marginal teeth which decrease in size laterally; summit on basal third; asperate in front of summit, the asperities rather abundant, large usually broad, occasionally arranged in one or more subconcentric rows, particularly near summit; posterior and lateral areas coarsely, closely, deeply punctured, granulate behind summit and near the lateral margins; pubescence consisting of rather short, fine, recumbent hair, coarse on asperate area.

Elytra shining; striae not impressed, the punctures fine, shallow, distinct, separated by a distance greater than their own diameters; interstriae two to three times as wide as the striae, the punctures fine, abundant, confused. Declivity rather steep, convex; the striae more obscure than on disc. Elytral vestiture consisting of uniserial rows of short hairlike strial setae, abundant, confused, short, interstrial scalelike setae; and uniserial rows of widely spaced, very long, slender, interstrial hairlike bristles, each bristle distinctly longer than distance between rows of bristles.

Male: Similar to the female.

Type Locality: Port Williams, Washington.

Host: Abies grandis, Pinus lambertiana, Pseudotsuga taxifolia, and *Sequoia sempervirens.*

Distribution: The Coastal Range from Vancouver Island, British Columbia, to San Francisco, California. Specimens from the following localities have been examined. *California:* Eureka, Marin Co. (Mount Tamalpais), and Muir Woods. *Oregon:* Astoria, Marshfield, Olimpic National Forest, and Santiam National Forest. *Washington:* Fort Flager, and Port Williams. *British Columbia:* Pender Harbor, and Saanichton.

The type specimens of *Cryphalus pubescens* and *C. subconcentralis* are in the U. S. National Museum.

Taenioglyptes rubentis (Hopkins)

Cryphalus piceae, Hopkins, 1899, W. Va. Agr. Exp. Sta., Bull. 56, p. 444; Felt, 1906, Mem. N. Y. State Mus., vol. 8, p. 753; Blatchley and Leng, 1916, Rhynchophora of North Eastern America, p. 606.

Cryphalus rubentis Hopkins, 1915, U. S. Dept. Agr., Rep. no. 99, p. 40; Blatchley and Leng, 1916, Rhynchophora of North Eastern America, p. 606; Chamberlin, 1939, The Bark and Timber Beetles of North America North of Mexico, p. 313.

This species is somewhat intermediate between *T. pubescens* and *T. ruficollis coloradensis,* but is readily distinguished by the granulate posterolateral areas of the pronotum, the obsolete strial punctures, and the interstrial bristles which are very long on the elytral disc and only one-half as long as the distance between rows of bristles on the declivity. These three forms are distinguished from other North American representatives of the genus by the presence of rather long interstrial bristles on the elytral declivity (not always true in *T. ruficollis coloradensis*).

Female: Length 1.60-1.95 mm., 2.29 times as long as wide, color light brown.

Frons convex with a weak transverse impression between the eyes and usually with a short, indistinct, median, longitudinal elevation above the epistoma; surface coarsely, shallowly rather closely punctured at sides; rather coarsely reticulate over a larger area;

pubescence consisting of inconspicuous, sparse, fine hair of medium length, and a more conspicuous ventrally directed epistomal brush. Eye broadly, rather shallowly emarginate; finely granulate. Antennal club longer than scape; about 1.40 times as long as wide; with three recurved sutures on the anterior face marked by rows of setae.

Pronotum 0.86 times as long as wide; anterior margin rather narrowly rounded, bearing from four to eight teeth, the four median ones usually subequal in size, the lateral ones reduced; summit on basal third; asperate in front of summit, the asperities rather abundant, large, usually narrow, confused; posterior and lateral areas coarsely, closely granulate, the punctures not evident; pubescence consisting of rather short, fine, recumbent hair, coarse on the asperate area.

Elytra shining; striae feebly or not at all impressed, the punctures obscure; interstrial punctures abundant, confused, very fine, surface almost smooth except for the punctures. Declivity rather steep, convex; the striae obsolete. Elytral vestiture consisting of uniserial rows of short, hairlike, strial setae; abundant, confused, short, interstrial, scalelike setae; and uniserial rows of widely spaced, long, slender, interstrial, hairlike bristles, each bristle on the disc about as long as the distance between rows of bristles, those on the declivity about one-half as long.

Male: Similar to the female.

Type Locality: Pocahontas County, West Virginia.

Host: Picea rubens.

Distribution: Known from Pennsylvania to North Carolina. Specimens from the following localities have been examined. *North Carolina-Tennessee:* Great Smoky National Park (near Clingman's Dome) *West Virginia:* Pocahontas County, and Randolph County, Blatchley and Leng (1916) add Pocono Lake, Pa.

The type specimen of *Cryphalus rubentis* is in the U. S. National Museum.

Taenioglyptes ruficollis ruficollis (Hopkins)

(Figs. 50, 51, 52)

Cryphalus ruficollis Hopkins, 1915, U. S. Dept. Agr., Rep. no. 99, p. 40; Chamberlin, 1939, The Bark and Timber Beetles of North America North of Mexico, p. 314.

Cryphalus approximatus Hopkins, 1915, U. S. Dept. Agr., Rep. no. 99, p. 41; Chamberlin, 1939, The Bark and Timber Beetles of North America North of Mexico, p. 315. Wood, 1951, Proc. Utah Acad. Sci., vol. 26, p. 128.

Cryphalus grandis Chamberlin, 1917, Can. Ent., vol. 49, p. 323; Chamberlin, 1939, The Bark and Timber Beetles of North America North of Mexico, p. 315.

Cryphalus canadensis Chamberlin, 1918, *in* Swaine, Dom. Can. Dept. Agr., Tech. Bull. 14, p. 88; Hopping, 1922, Can. Ent., vol. 54, p. 131; Chamberlin, 1939, The Bark and Timber Beetles of North America North of Mexico, p. 314.

Cryphalus mainensis Blackman, 1922, N. Y. State College of Forestry, Tech. Pub. 16, p. 126; Chamberlin, 1939, The Bark and Timber Beetles of North America North of Mexico, p. 314.

This widely distributed form is closely allied to *T. fraseri* and *T. ruficollis coloradensis;* it differs from *T. fraseri* by the distinctly impressed strial punctures, and the less granulate posterolateral areas of the pronotum. From *T. r. coloradensis* it is distinguished by the more closely punctured pronotum, with at least the posterolateral angles granulate, and the smaller average body size.

Female: Length 1.45-1.85 mm., 2.30 times as long as wide, body color dark brown.

Frons weakly convex, with a short, often indistinct, median, longitudinal elevation near epistoma; surface coarsely reticulate over a larger area; pubescence consisting of inconspicuous, sparse, fine hair of medium length, and a more conspicuous ventrally directed epistomal brush. Eye broadly, shallowly emarginate; finely granulate. Antennal club longer than scape, about 1.17 times as long as wide, with three recurved sutures on anterior face marked by rows of setae.

Pronotum 0.84 times as long as wide; anterior margin rather broadly rounded, bearing from four to eight marginal teeth which decrease in size laterally; summit on basal third; asperate in front of summit, the asperities rather abundant, large, usually narrow, rarely arranged in one or more subconcentric rows near summit; posterior and lateral areas closely, rather finely, deeply granulate-punctate; more granulate basally, particularly in the posterolateral angles; pubescence consisting of rather short, fine, recumbent hair, coarse on asperate area.

Elytra shining; striae usually not impressed, the punctures distinctly impressed, rather fine, separated by a distance greater than their own diameters; interstriae two to three times as wide as striae, the punctures fine, abundant, confused. Declivity rather steep, convex, the strial and interstrial punctures obsolete. Elytral vestiture consisting of uniserial rows of short, hairlike, strial setae; abundant, confused, short, interstrial, scalelike setae; and uniserial rows of widely spaced, rather long, slender, interstrial bristles on the disc, each bristle distinctly longer than the distance between rows of bristles.

Male: Similar to the female, but usually the elytral scales are slightly larger.

Type Locality: Alta, Utah.

Hosts: Abies amabilis, A. grandis, A. lasiocarpa, A. magnifica, Picea engelmanni, P. glauca, and *P. rubens.*

Distribution: Maine to British Columbia, south in the high mountains to Utah and Oregon. Specimens from the following localities have been examined. *Idaho:* Sand Point. *Maine:* Orono. *Montana:* Glacier National Park. *New York:* Cranberry Lake. *Utah:* Alta, and Logan Canyon. *Washington:* Metaline Falls, and Naches Ranger Station. *British Columbia:* Hope Mountain, London Hill Mine near Bear Lake, Nicomin Ridge, Rogers Pass, and Stanley. *New Brunswick:* Prince Edward Island. *Quebec:* Gaspe.

The type specimens of *Cryphalus ruficollis, C. approximatus,* and *C. mainensis* are in the U. S. National Museum; that of *C. canadensis* is in the Canadian National Collection; and that of *C. grandis* evidently has not been designated.

Taenioglyptes ruficollis, recognized at present as occurring through the northern coniferous forests from British Columbia to New Brunswick, has evidently given rise to a distinct geographic form in each of the three mountain systems along the southern limits of its current distribution. Biological data are available only for the eastern, or Appalachian form which is recognized here as *T. fraseri.* Its hosts are limited to the genus *Abies,* while in the area of overlapping distribution the northern *T. r. ruficollis* is evidently limited to *Picea* species. The larval tunnels of the eastern *T. fraseri* are more or less regular and oriented to parallel the grain of the wood; in *T. r. ruficollis* these tunnels are irregular and not oriented with respect to the grain of the wood. These forms are also morphologically distinct and evidently do not interbreed; they are without doubt specifically distinct.

The form found in the Colorado River drainage region of the southern Rocky Mountains is morphologically more distinct from *T. r. ruficollis* than is *T. fraseri;* however, its distribution and biology have not been fully determined. Specimens collected about two hundred miles south, and others collected about three hundred miles east of the type locality of *T. r. ruficollis* show no evidence of intergradation. At present their ranges are not known to overlap, but it is possible that they do in central or eastern Utah. In the absence of biological data the morphological distinctness of the southern form warrants the recognition of *T. r. coloradensis* as a distinct subspecies; additional knowledge of its distribution and biology may eventually prove it to be a separate species.

A gradual change in elytral and pronotal characters of *T. r. ruficollis* begins in Washington and Oregon and increases southward. In most specimens from western Washington and northwestern Oregon the modifications of these characters are scarcely noticeable; however, they are quite distinct in specimens from east-central California. In the absence of sufficient biological information, the complete intergradation of morphological characters suggests the recognition of a subspecies to distinguish the southern Coastal-Sierran form from the widely distributed northern form. Although the cotypes examined do not fully express the subspecific characters, the name *T. r. amabilis* is employed for this subspecies.

Taenioglyptes ruficollis amabilis (Chamberlin)

Cryphalus amabilis Chamberlin, 1917, Can. Ent., vol. 49, p. 321; Chamberlin, 1918, Ore. Agr. Exp. Sta., Bull. 147, p. 13; Chamberlin, 1939, The Bark and Timber Beetles of North America North of Mexico, p. 312; Patterson and Hatch, 1945, Univ. Wash. Pub. Biol., vol. 10, p. 152.

This subspecies intergrades completely with *T. r. ruficollis*, but specimens from the southern part of its distribution may be distinguished by the more distinctly punctured posterior lateral areas of the pronotum, the more prominent striae and strial punctures, and the smoother interstriae. With these exceptions the description is the same as that of *T. r. ruficollis.*

Type locality: Elk Lake, Linn County, Oregon.

Hosts: Abies amabilis, A. mangifica, and *Pseudotsuga taxifolia.*

Distribution: Western Oregon to central California. Specimens from the following localities have been examined. *California:* Devils Post Pile National Monument. *Oregon:* Elk Lake, Linn County, and Santiam National Forest.

Taenioglyptes ruficollis coloradensis, new subspecies

This subspecies is closely allied to *T. r. ruficollis,* differing by the larger, more widely spaced punctures in the posterolateral areas of the pronotum, the absence of a granulate area at the posterolateral angles of the pronotum, and the larger average size. In most of the specimens a few interspacial bristles are present on the declivity, each about one-half as long as the distance between rows of bristles; in the only male observed these declivital bristles are regularly spaced, similar to those of *T. abeitis* of Europe and *T. rubentis* of the eastern United States.

Female: Length 1.65-1.95 mm., 2.30 times as long as wide, body color dark brown.

Frons weakly convex, with a short, often indistinct, median, longitudinal elevation near the epistoma; surface coarsely reticulate over a larger area; pubescence consisting of inconspicuous, sparse, fine hair of medium length, and a more conspicuous ventrally directed epistomal brush. Eye broadly, rather deeply emarginate; finely granulate. Antennal club longer than scape, about 1.40 times as long as wide, with three recurved sutures on anterior face marked by rows of setae.

Pronotum 0.87 times as long as wide; anterior margin rather broadly rounded with three to six teeth, the median pair slightly larger; summit on basal third; asperate in front of summit, the asperities rather abundant, large, occasionally arranged in one or more subconcentric rows, particularly near summit; posterior and lateral areas coarsely, rather closely, deeply punctured, sometimes granulate-punctate, completely granulate behind summit; pubescence consisting of rather short, fine, recumbent hair, coarse on asperate area.

Elytra shining; striae not impressed, the punctures moderately large, shallow, quite distinct, separated by a distance greater than their own diameters; interstriae about one and one-half times as wide as striae, the punctures fine, abundant, confused, the surface rugulose on basal two thirds of disc. Declivity rather steep, convex; striae more obscure than on disc. Elytral vestiture consisting of uniserial rows of short hairlike strial setae; abundant, confused, short, interstrial scalelike setae; and uniserial rows of widely spaced, rather long, slender, interstrial, hairlike bristles, each bristle on both the disc and declivity about one-half as long as the distance between rows of bristles; the bristles on the declivity usually reduced in number, often fewer than three or four on the entire declivity.

Male: Similar to the female. In the only recognizable male the elytral bristles are more abundant on the declivity.

Type Locality: Seven miles north of Grand Canyon National Park, Arizona.

Hosts: Abies concolor, A. lasiocarpa, and *Pseudotsuga taxifolia.*

Distribution: Northern Arizona and southern Utah, to Colorado. The female holotype and 68 paratypes were collected Sept. 25, 1949 by S. L. Wood; the male allotype and seven paratypes from Colorado National Forest, Colorado, July 2, 1927 by M. W. Blackman; and four paratypes from Beaver, Utah, Sept. 10, 1949 by S. L. Wood.

The holotype and 12 paratypes are located in the Snow Entomological Collections; the allotype and 12 paratypes are located in the U. S. National Museum; additional paratypes are in the collections of T. O. Thatcher and the author.

Taenioglyptes fraseri (Hopkins)

Cryphalus fraseri Hopkins, 1915, U. S. Dept. Agr., Rep. no. 99, p. 40; Blatchley and Leng, 1916, Rhynchophora of North Eastern America, p. 607; Chamberlin, 1939, The Bark and Timber Beetles of North America North of Mexico, p. 313.

Cryphalus balsameus Hopkins, 1915, U. S. Dept. Agr., Rep. no. 99, p. 41; Blatchley and Leng, 1916, Rhynchophora of North Eastern America, p. 607; Swaine, 1918, Dom. Can. Dept. Agr., Tech. Bull. 14, p. 89; Dodge, 1938, Minn. Agr. Exp. Sta., Tech. Bull. 132, p. 39; Chamberlin, 1939, The Bark and Timber Beetles of North America North of Mexico, p. 313.

This species is closely allied to *T. r. ruficollis,* but differs by the obsolete strial punctures, and the more completely granulate posterior-lateral areas of the pronotum. It resembles *T. rubentis,* but the long interstrial bristles on the declivity are absent, the discal bristles are much shorter, and the surface of the elytra is rugulose.

Female: Length 1.5-2.1 mm., 2.35 times as long as wide, body color brown.

Frons convex with a weak transverse impression between eyes and usually with a short, indistinct, median, longitudinal elevation near the epistoma; surface coarsely, shallowly, rather closely punctured at sides, rather coarsely reticulate over a larger area; pubescence consisting of inconspicuous, sparse, fine hair of medium length, and a more conspicuous ventrally directed epistomal brush. Eye broadly, rather shallowly emarginate; finely granulate. Antennal club longer than scape, about 1.42 times as long as wide, with three recurved sutures on the anterior face marked by rows of setae.

Pronotum 0.82 times as long as wide; anterior margin rather narrowly rounded, bearing from four to eight teeth, the four median ones usually subequal in size, the lateral ones reduced; summit on basal third; asperate in front of summit, the asperities rather abundant, large, usually narrow, confused; posterior and lateral areas closely, rather coarsely granulate, punctures usually evident only near asperate area; pubescence consisting of rather short, fine, recombent hair, coarse on asperate area.

Elytra shining; striae weakly or not at all impressed, the punctures obsolete; interstriae finely, closely granulate-punctate. Declivity rather steep, convex; striae obsolete; interstriae finely punctured. Elytral vestiture consisting of uniserial rows of short, hairlike, strial setae; abundant, confused, short, interstrial, scalelike setae; and uniserial rows of widely spaced, rather long, slender, interstrial, hairlike bristles on the disc, each bristle about one-half as long as the distance between rows of bristles, obsolete on the declivity.

Male: Similar to the female.

Type Locality: Pisgah Ridge, North Carolina.

Hosts: Abies balsamea, and *A. fraseri.*

Distribution: Northern Minnesota to Maine, south to North Carolina. Specimens from the following localities have been examined. *Maine:* Bar Harbor, Camp Carabou, and Orono. *Michigan:* Charlevoix County. *Minnesota:* Itasca County. *New York:* Cranberry Lake, Green County, and Ithaca. *North Carolina* and *Tennessee:* Great Smoky National Park near Clingman's Dome, and Pisgah Ridge, N. C. *Pennsylvania:* Pocono Lake. *Quebec:* Isle Perrot, Howick, Memphremagog, Monte Bello, and St. Anne's.

The type specimens of *Cryphalus fraseri* and *C. balsameus* are in the U. S. National Museum.

Cryptocarenus Eggers

Cryptocarenus Eggers, 1933, Trav. Lab. d'Ent. Mus. Natl. d'Hist. Nat. (Paris), Mem. Orig. no. 1, p. 10 (*nomen nudum*)*; Eggers, 1937, Revista de Ent., vol. 7, p. 79; Schedl, 1939, Arb. Morph. Tax. Ent. Berlin-Dahlem, vol. 6, p. 46; Schedl, 1951, Dusenia, vol. 2, p. ? (between 71-130).

Tachyderes Blackman, 1943, Jour. Wash. Acad. Sci., vol. 33, p. 35.

The genus *Cryptocarenus* was described by Eggers (1933 and 1937) to include a group of Neotropical species. Blackman (1943) included two Neotropical and one additional species from southern Florida in his genus *Tachyderes*; however, Schedl (1951) found the two genera to be synonymous and submerged the name *Tachyderes.*

Blackman (1943) and Schedl (1939) placed this genus in the Pityophthorini; however, because of the pronounced sexual dimorphism, the differences between the anterior and posterior faces of the antennal club, the larger more isolated pronotal asperities, the metepisternum not covered posteriorly by the elytra, and the posterior tibiae similar to those of *Stephanoderes,* it should be placed in the Cryphalini.

Cryptocarenus is closely allied to *Stephanoderes,* but differs by having the antennal club without a septum, the raised lateral line of the pronotum much longer, and the elytra subglabrous except for a few subcapitate bristles.

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* In 1933, Eggers assigned two new species to *Cryptocarenus*, but did not describe the genus nor designate a type species; however, in a footnote he did refer to a complete description of the genus which was to appear in another work. Prior to January 1, 1931, that footnote would have been sufficient to establish priority for the earlier date. If the current International Rules of Zoological Nomenclature are to be followed, *Cryptocarenus* Eggers was first used as a valid generic name in 1937; prior to that time it must be regarded as a nomen nudum.

Female larger than male, about 1.6-2.4 mm., 2.6 times as long as wide; male smaller, about 65 percent as large as female; body color reddish-brown.

Frons with a transverse or median impression between eyes; a series of tubercles at upper limits of impression; punctures rather coarse, pubescence inconspicuous except for the epistomal brush. Eye rather coarsely granulate; emarginate. Antennal funicle five-segmented in female, four-segmented in male; segments two to five increasing in width distally; club oval, flattened, not constricted, with three procurved sutures on both sides marked only by rows of setae.

Pronotum about 0.98 times as long as wide; basal and posterior two thirds of lateral margin with a fine elevated line; asperate in front of summit; anterior margin armed with about eight teeth, several of these may be absent in male. Fore tibiae with serrations of outer margin on more than distal two thirds. Hind tibiae slender; three or four teeth on distal margin.

Elytral striae not impressed, except the first, the punctures fine, and shallow; interstriae smooth, with or without punctures; declivity convex, rather steep; vestiture scanty, consisting of minute, recumbent strial hair, and long, erect, usually subcapitate, interstrial bristles.

Type Species: Cryptocarenus diadematus Eggers, original designation.

KEY TO THE SPECIES OF CRYPTOCARENUS

1. Frons transversely impressed from eye to eye, with one median tubercle at upper level of eyes; elytral interspaces with numerous, extremely minute, confused punctures; second declivital interspace not strongly impressed; length 1.6-1.7 mm. .... *porosus*

   Frons weakly concave between eyes, with a transverse row of five to nine tubercles at the upper level; coarsely rugose at sides of the impression; elytral interspaces smooth; second declivital interspace flat; larger 2.2-2.4 mm.; Florida .... *floridensis*

Cryptocarenus floridensis (Blackman)

(Figs. 55, 94)

Tachyderes floridensis Blackman, 1943, Jour. Wash. Acad. Sci., vol. 33, p. 36.

The larger size, the narrower, deeper frontal impression with larger, more abundant tubercles at its upper limit, and the more coarsely sculptured frons distinguish this species from *C. porosus.*

Female: Length 2.2-2.4 mm., 2.65 times as long as wide, body color reddish-brown.

Frons concavely impressed, width of impression equal to about one-half distance between eyes; surface rather coarsely punctured, coarsely rugose at sides; a row of about five to nine prominent tubercles along upper limits of impression, the median one larger; pubescence consisting of fine, short, inconspicuous hair, more abundant and forming a ventrally directed brush along epistoma. Eye large, emarginate; very coarsely granulate. Antennal club about as long as scape, 1.20 times as long as wide; the sutures rather strongly procurved, indicated by rows of setae.

Pronotum about 0.98 times as long as wide; anterior margin with about seven or eight, large, subcontiguous teeth; summit at middle; asperate in front of summit, with rugosities from the asperate area continuing posteriorly, those near the lateral margin reaching the base; posterior and lateral areas shining, finely, shallowly, sparsely punctured; pubescence consisting of inconspicuous, fine, short, sparse hair, slightly longer in asperate area.

Elytra shining, subglabrous; only the first striae impressed, the punctures fine, very shallow, separated by a distance greater than their own diameters (variable); interstriae about twice as wide as striae, impunctate. Declivity moderately steep, convex; striae one and two impressed; interspace two impressed, narrower apically. Elytra subglabrous on disc; minute strial hairs, and longer, sparse, subcapitate interstrial bristles more conspicuous on declivity and sides.

Male: Similar to the female except: length 1.5-1.6 mm., 2.5 times as long as wide; eye reduced in size, about two-thirds as large as in female; funicle four-segmented; one or more of teeth may be absent from anterior margin of pronotum; striae and strial punctures obscure; and declivity not as steep. Because of similar color and size it could easily be confused with female of *C. porosus.*

Type Locality: Paradise Key, Florida.

Hosts: Chenopodium ambrosioides, Coccolobis laurifolia, Conocarpus erecta, Dipholis salicifolia, Ficus aurea, Galactea spiciformis, Ipomoea pres-caprae, Metopium toxiferum, Ocotea catesbyana, Persea borbonia, Pithecellobium unguis-cati, P. guadelupense, Rhizophora mangle, Rhus radicans, Torrubia longifolia, and *Vitis* spp.

Distribution: Southern Florida, from Sebring to Key West; southern Texas to Tampico, Mexico; the Virgin Islands, and Haiti. Specimens from the following localities have been examined.

Florida: Everglades National Park, Grassy Key, Key Largo, Matacumba Key, Ochoppee, Paradise Key, Plantation Key, Royal Palm Hammock State Park, and Sugar Loaf Key.

The type specimen of *Tachyderes floridensis* is in the U. S. National Museum.

Cryptocarenus porosus, new species

(Figs. 16, 17, 30, 38, 54, 93)

The small body size; the transversely impressed (not concave) frons with only one median frontal tubercle; the smaller, more finely granulate eye; and the presence of numerous, extremely minute, confused, interstrial punctures distinguish this species from *C. floridensis.* It is closely allied to *C. heveae* (from Africa), but *C. heveae* has the interstrial punctures of the elytra slightly larger, and the marginal teeth of the pronotum are narrower and distinctly separate.

Female: Length 1.6-1.7 mm., 2.62 times as long as wide, body color dark reddish-brown.

Frons strongly, transversely impressed between eyes; surface very coarsely punctured, particularly above and at sides; a large, median tubercle with a subcarinate dorsal extension at upper level of eyes; pubescence consisting of fine, short, inconspicuous hair, more abundant and forming a ventrally directed brush along epistoma. Eye emarginate; not coarsely granulate. Antennal club about as long as scape, 1.04 times as long as wide; the sutures rather strongly procurved, indicated by rows of setae.

Pronotum about 0.98 times as long as wide; anterior margin with about seven or eight, large, subcontiguous teeth; summit at middle; asperate in front of summit; posterior and lateral areas shining, finely, shallowly, sparsely punctured; pubescence consisting of inconspicuous, fine, short, sparse hair, slightly longer in asperate area.

Elytra shining, subglabrous; only the first striae impressed, the punctures fine, shallow, separated by a distance greater than their own diameters; interstriae about twice as wide as striae, the punctures extremely minute, very abundant, confused. Declivity moderately steep, convex; striae one and two impressed; interspace two not as strongly impressed or as narrow as in *C. floridensis.* Elytra subglabrous on disc, with the minute strial hairs; longer, sparse, subcapitate interstrial bristles, more conspicuous on declivity and sides.

Male: Similar to the female except: length 1.0 mm., about 2.5 times as long as wide; eye reduced, about two-thirds as large as in female; funicle four-segmented; several teeth may be absent from anterior margin of pronotum; striae and strial punctures obscure; declivity not as steep.

Type Locality: Royal Palm Hammock State Park, Florida.

Host: *Vitis* sp.

Distribution: The female holotype and one female paratype were collected June 22; the male allotype, one female paratype, and two additional damaged females were collected at the Everglades National Park, July 6; all were collected in 1951 by R. D. Price, R. H. and L. D. Beamer, and S. L. Wood.

The holotype and allotype are in the Snow Entomological Collections, the paratypes are in the collection of the author.

Stephanoderes Eichhoff

Stephanoderes Eichhoff, 1871, Berlin Ent. Zeitschr., vol. 15, p. 132; Eichhoff, 1879, Ratio . . . Tomicinorum, p. 142; Eichhoff, 1881, Europäischen Borkenkäfer, pp. 46, 190; Eichhoff, 1883, Rev. d'Ent., vol. 5, pp. 110, 134; Eichhoff and Schwarz, 1896, Proc. U. S. Nat. Mus., vol. 18, p. 608; Swaine, 1909, N. Y. State Mus., Bull. 134, p. 116; Hagedorn, 1910, Coleopterorum Catalogus, pars. 4, p. 40; Hagedorn, 1910, Genera Insectorum, fasc. 111, p. 84; Hopkins, 1915, U. S. Dept. Agr., Rep. no. 99, p. 21; Blatchley and Leng, 1916, Rhynchophora of North Eastern America, p. 599; Swaine, 1918, Dom. Can. Dept. Agr., Tech. Bull. 14, p. 45; Leng, 1920, Catalogue of the Coleoptera of America North of Mexico, p. 340; Blackman, 1922, Miss. Agr. Exp. Sta., Tech. Bull. 11, p. 89; Chamberlin, 1939, The Bark and Timber Beetles of North America North of Mexico, p. 303; Schedl, 1940, An. Esc. Nac. Cienc. Biol. (Mexico), vol. 1, p. 342; Blackwelder, 1947, U. S. Nat. Mus., Bull. 185, p. 777.

The genus *Stephanoderes* was described by Eichhoff (1871) to include seven species. Later he (in Eichhoff and Schwarz, 1896) regarded *Stephanoderes* and *Hypothenemus* as synonymous and submerged the name *Hypothenemus* since it was established on the basis of a non-existent three-segmented antennal funicle (although it may be three segmented in some males of *Hypothenemus*). Reitter (1894) and Hagedorn (1910a) included *Stephanoderes* as a subgenus of *Cryphalus;* Swaine (1909) used it as a subgenus of *Hypothenemus.* In 1914, Hopkins designated *S. chapuisii* as the type species and in 1915, established *Stephanoderes* as a valid genus.

A thorough study of all known species of *Hypothenemus* and *Stephanoderes,* particularly those from the tropics, would probably result in the reduction in rank of *Stephanoderes* to that of a subgenus or a possible synonym of *Hypothenemus.* For example, they (including tropical species) intergrade with respect to body size, body form and proportion, type of vestiture, arrangement and size of pronotal asperities, tibial armature, and characters of the frons, eye, antennal club, etc. The only character thought to be reliable, the five-segmented antennal funicle in *Stephanoderes* (four-segmented in *Hypothenemus*), in S. *castaneus* has from three to five segments (some segments usually partly fused to others). However, at present both generic names are retained, because in the North American fauna they designate two distinct, rather easily separated groups of species.

The genus *Stephanoderes* may be distinguished from allied genera as follows: the antennal funicle five-segmented; the antennal club constricted at the partly septate first suture; the fore tibiae with teeth on only the distal one fourth, and the elytra usually coarsely striate. The smaller North American *Stephanoderes* can also be readily distinguished from *Hypothenemus* by the presence of a single row of short hairlike setae (arising from the strial punctures) between the rows of scalelike bristles. The *Hypothenemus*, and the S. *dissimilis* and S. *obesus* groups, have abundant, short, interstrial setae in addition to the rows of bristles.

Female larger than the male, length 1.1-2.4 mm., 2.3-2.5 times as long as wide; male smaller, about three-fourths as large as female, 2.0-2.2 times as long as wide; body color light brown to black; vestiture consisting of hairlike and scalelike setae.

Frons broad, convex, often with a median groove or elevation, rarely with a transverse elevation; punctures and pubescence usually not prominent. Eye sinuate to shallowly emarginate; finely granulate, its size reduced in male to as little as one-third that of female. Antennal funicle five-segmented in female, usually four-segmented in male, the segments increasing in width distally; club elongate, smaller and narrower in male than in female; flattened, with three sutures on both sides, the first partly septate, the second and third marked only by setae.

Pronotum 0.8-1.0 times as long as wide, the length never exceeding the width; basal margin and posterior one third of lateral margin with a fine, elevated line; asperate in front of summit; anterior margin armed with two to six teeth (part or all of these may be absent in the male). Fore tibiae with five teeth (rarely four to six) on distal one fourth. Hind tibia slender; four teeth on distal margin.

Elytral striae usually distinctly impressed, with rather coarse, close, deep punctures; interstriae usually almost smooth, with a fine puncture at the base of each seta; declivity usually steep, convex, without special prominences or impressions; vestiture consisting of rows of erect, rather long, interstrial bristles, and short, recumbent strial or interstrial setae.

Type Species: (*Stephanoderes chapuisii* Eichhoff=) *Crypturgus dissimilis* Zimmermann, subsequent designation (Hopkins, 1914).

KEY TO THE SPECIES OF STEPHANODERES

1. Pronotum with about 8-25 asperities on anterior slope, and with two to four teeth on anterior margin; elytra (at least on declivity) with uniserial rows of long, erect, interstrial bristles, and abundant, short, recumbent, strial and interstrial setae; frons convex, without a median impression or elevation, or with a prominent transverse carina and a distinct impression below this carina; larger species, the females 1.5-2.4 mm. (some *brunneus* 1.35 mm.) 2

   Pronotum more slender, with asperities more abundant and smaller (more than 25), and with at least four teeth on anterior margin (rarely two or three in *sparsus*); elytra with uniserial rows of erect interstrial bristles and minute, inconspicuous, strial setae, one arising from each puncture; frons usually with a median longitudinal impression or elevation; smaller species, females 1.1-1.6 mm. (rarely 1.7 mm.) 8

2. Frons uniformly convex; anterior pronotal margin with two to four subcontiguous teeth, the lateral ones, when present, distinctly smaller; elytral striae with punctures impressed 3

   Frons with a transverse carina at upper level of eyes, flattened or slightly concave below this point; anterior margin of pronotum with two widely separated teeth, or with four teeth, the median pair distinctly smaller; elytral striae with punctures obscure, particularly on declivity 7

3. Elytral interspaces on declivity with short, semirecumbent, scale- or hairlike setae, and rows of long, slender, erect, hairlike setae; base of pronotum never with scalelike pubescence; anterior pronotal margin with two teeth 4

   Elytra with numerous, short, recumbent, hairlike setae and uniserial rows of long, erect, broad, interstrial scales; pronotum with scalelike setae on basal third; anterior pronotal margin with two to four teeth 5

4. Elytral declivity flattened, with third interspace slightly elevated and strial punctures as large as on disc; discal interspaces and striae about equal in width; declivital pubescence consisting of abundant, long, coarse, pointed bristles intermixed with shorter, similar bristles; posterior area of pronotum rather coarsely punctured, subaciculate behind summit . . . . *hirsutus*

   Elytral declivity convex, with strial punctures small; discal interspaces at least one and one-half times as wide as striae; declivital pubescence consisting of abundant, short, semirecumbent scales, and less abundant, long, slender, erect hair; granulate behind summit . . . . *dissimilis*

5. Interspacial scales of declivity about three-fourths as long as distance between rows of scales; anterior pronotal margin with two teeth; about 8-12 coarse asperities between anterior margin and summit of pronotum . . . . *rotundicollis*

Interstrial scales on declivity as long as distance between rows of scales; anterior margin of pronotum with four teeth (the lateral pair much smaller); at least 15 coarse asperities between anterior margin and summit of pronotum 6

6. Declivital scales narrower, more than four times as long as wide; size larger than 1.8 mm.; antennal funicle five-segmented in female; southern Texas . . . . *erectus*

Declivital scales broad, two to three times as long as wide; smaller than 1.8 mm.; antennal funicle usually three-segmented in female; southern Florida . . . . *castaneus*

7. Lateral areas of pronotum shallowly, densely punctured; anterior margin of pronotum with four teeth, the median pair smaller; interstrial bristles narrow, not increasing in width distally; transverse frontal carina less sharply elevated, impression below this carina deeper and narrower, occupying about one half the distance between eyes; larger than 1.55 mm. . . . . *obesus*

Pronotum indistinctly punctured laterally, subgranulate behind summit; anterior margin with two widely separated teeth, rarely one or two smaller teeth between them; interstrial bristles more distinctly flattened, increasing in width distally; transverse frontal carina more sharply elevated, the impression broad, occupying at least three fourths of the distance between eyes; frons more coarsely punctured; smaller than 1.5 mm. . . . . *brunneus*

8. Declivital bristles narrow, at least four times as long as wide (three times in some *squamosus*); frons usually with a median impression, never with a median elevation; anterior margin of pronotum with four teeth of equal size, rarely with one or two additional granules 9

Declivital bristles broad, less than three times as long as wide; frons either with a median impression or elevation or both (not always prominent); anterior margin of pronotum normally with six or more teeth (only four in *niger* and *sparsus*) 12

9. Setae along costal margin of elytra hairlike, at least anteriorly; declivital bristles much narrower, at least five times as long as wide 10

Setae along costal margin of elytra scalelike; declivital bristles rather broad, about four times as long as wide 11

10. Declivital bristles narrower, frequently almost hairlike laterally on or near the ninth interspace; setae along entire costal margin of elytra hairlike; the median frontal impression usually very short, often a single puncture . . . . *interstitalis*

Declivital bristles rather wide, longer but never hairlike laterally; setae along costal margin of elytra hairlike only on anterior half; frontal impression a narrow groove, beginning at upper level of eyes and usually extending about one half the distance to epistomal margin; usually smaller, 1.25-1.55 mm. . . . . *nitidipennis*

11. Declivity convex, without a lateral elevation; elytral interspaces almost smooth, bristles narrower; frontal groove narrow, extending

from upper level of eyes about three fourths of the distance to epistomal margin; an exotic species occasionally found in imported Brazil nuts . . . . *rufescens*

Declivity somewhat flattened, laterally margined by a subcarinate elevation extending from junction of interspaces five and seven to junction of interspaces one and nine; elytral surface rugose; interspacial scales rather broad; frontal groove usually short and rather inconspicuous; southern Florida to Cuba . . . . *squamosus*

12. Anterior margin of pronotum normally with four teeth, the median pair slightly larger; bristles on ninth interspace at base of declivity long, slender, and pointed, at least five times as long as wide; declivital striae impressed, the interspaces slightly raised and coarsely granulate; southern Texas . . . . *niger*

Pronotal margin normally with six teeth (except *sparsus*); ninth interspacial bristles at base of declivity rather broad and scale-like; declivital striae less strongly impressed, interspaces and granules not as large 13

13. Length less than 1.3 mm.; pronotal margin with four teeth (often fewer); lateral areas of pronotum usually with a small granule at base of each scale; elytral interspaces uniserially, coarsely granulate; each elytral scale shorter than distance between rows of scales, about one and one-half times as long as wide; southern Texas . . . . *sparsus*

Length greater than 1.4 mm.; anterior margin of pronotum normally with six or more teeth; elytral interspaces with granules indistinct or absent; lateral areas of pronotum shallowly punctured 14

14. Frons distinctly, subtuberculately elevated medially at upper level of eyes, a narrow groove extending from summit of elevation about one fourth to three fourths of the distance to the epistoma, slightly concave longitudinally between summit of elevation and epistomal margin; teeth on anterior margin of pronotum subequal in size; declivital bristles two to three times as long as wide . . *obscurus*

Frons convex, at least not longitudinally concave on lower half, without a median tuberculate elevation; either lateral teeth on anterior margin of pronotum reduced in size, or more widely spaced; declivital bristles usually shorter, less than two times as long as wide 15

15. Frons with coarse, close, deep punctures; marginal teeth of pronotum subequal in size, widely spaced, separated by width of one tooth or more . . . . *andersoni*

Frons coarsely reticulate, with inconspicuous, rather small, sparse, shallow punctures; lateral pair of teeth on pronotal margin smaller, 16

16. Pronotum more finely punctured, the punctures not granulate behind summit; interstrial punctures not granulate on disc; stouter, usually larger . . . . *liquidambarae*

Pronotum granulate behind summit; interstrial punctures subgranulate; more slender, usually smaller . . . . *georgiae*

Stephanoderes hirsutus, new species

(Figs. 56, 95)

This species is closely allied to S. *dissimilis,* but differs as follows: elytral declivity distinctly flattened; third declivital interspace slightly elevated; declivital bristles longer, coarser, and more abundant; strial punctures larger and deeper; interstrial punctures usually larger and less abundant; and the posterior areas of the pronotum more coarsely punctured and subaciculate. The male distinguished from the male of S. *dissimilis* by the absence of short, scalelike setae on the declivity, coarser more abundant declivital bristles, and more strongly impressed first and second declivital striae. The absence of scalelike setae on the pronotum, and the presence of interspacial rows of pointed, hairlike setae on the elytra distinguish S. *hirsutus* and S. *dissimilis* from other North American representatives of the genus.

Female: Length 1.7-1.9 mm., 2.32 times as long as wide, body color black, antennae and legs testaceous.

Frons evenly convex, finely aciculate; punctures of moderate size, depth and density. Eye emarginate; finely granulate. Antennal club longer than scape, about 1.36 times as long as wide; the first suture slightly procurved, the second and third bisinuate.

Pronotum about 0.85 times as long as wide, with two rather large contiguous teeth on anterior margin, and about 8 to 14 large asperities between summit and anterior margin; summit rather high, located behind middle; posterior and lateral areas with coarse, close, deep punctures, becoming subaciculate behind summit; pubescence consisting of rather long, moderately abundant hair.

Elytra shining; striae slightly impressed, about as wide as interstriae; strial punctures close, separated by less than one half their own diameters; interstrial punctures in irregular rows, about one-third as large as the strial punctures and separated by one to four times their own diameters. Declivity rather steep, appearing flattened because of the slightly impressed second interspace and the slightly elevated third interspace; the posterior portion of interspaces five and nine usually elevated, although this is not consistent. Elytral vestiture on disc consisting of rows of erect, pointed interspacial bristles, each bristle shorter than the distance between rows of bristles; and of short inconspicuous, recumbent strial hair; the interstrial bristles on declivity sharply pointed, considerably more abundant and longer than on disc, the longest may be at least twice as long as the distance between the irregular rows of bristles; the strial hair more nearly erect, and slightly longer than on disc.

Male: Similar to the female except: length 1.3-1.5 mm., 2.0 times as long as wide; the eye reduced in size, about one-half as large as in female; antennal club more slender; antennal funicle usually four-segmented; summit of pronotum slightly higher; asperities narrower; anterior margin of pronotum usually without teeth, although one or two teeth may be present; elytral striae and punctures less distinct, the second declivital interspace not as strongly impressed; and elytral vestiture somewhat longer on sides and disc.

Type Locality: Plantation Key, Florida.

Hosts: Achras sapota, Ardisia paniculata, Eugenia buxifolia, Ipomoea cathartica, Lysiloma bahamensis, Metopium toxiferum, Pithecellobium guadelupense, P. unguis-cati, and *Reynosia septentrionalis.*

Distribution: The Florida Keys from Key Largo south to Key West. The female holotype, male allotype, and 24 paratypes were collected June 26. In addition 53 paratypes were from Grassy Key, June 27; Key Largo, June 25; Key Vaca, June 29; Matacumba Key, June 28; Sugar Loaf Key, July 3 (all were collected in 1951 by R. D. Price, R. H. and L. D. Beamer, and S. L. Wood); Big Pine Key, March 6, by Barber; Marathon (Key Vaca), March 7-8; and Key West, April 6, 1903 by E. A. Schwarz.

The holotype, allotype and 10 paratypes are in the Snow Entomological Collections; additional paratypes are in the collections of the U. S. National Museum, Canadian National Collection and the author.

Stephanoderes dissimilis (Zimmermann)

(Figs. 1, 2, 3, 4, 22, 23, 24, 31, 39, 57, 96)

Crypturgus dissimilis Zimmermann, 1868, Trans. Amer. Ent. Soc., vol. 2, p. 144; Eichhoff, 1879, Ratio . . . Tomicinorum, p. 144.

Hypothenemus dissimilis, Leconte, 1876, Proc. Amer. Phil. Soc., vol. 15, p. 356; Schwarz, 1878, Proc. Amer. Phil. Soc., vol. 17, p. 468; Schwarz, 1888, Proc. Ent. Soc. Wash., vol. 1, p. 80; Smith, 1890, Ent. Amer., vol. 6, p. 54; Smith, 1890, Catalogue of the Insects of New Jersey, p. 267; Chittenden, 1893, Proc. Ent. Soc. Wash., vol. 2, p. 393; Hopkins, 1893, W. Va. Agr. Exp. Sta., Bull. 31, p. 133; Hopkins, 1893, W. Va Agr. Exp. Sta., Bull. 32, p. 210 Hamilton, 1895, Trans. Amer. Ent. Soc., vol. 22, pp. 346, 378; Chittenden, 1895, Ins. Life, vol. 7, p. 385; Lintner, 1896, N. Y. Report 11, p. 270; Wenzel, 1905, Ent. News, vol. 16, p. 124.

Stephanoderes dissimilis, Smith, 1900, Catalogue of the Insects of New Jersey, p. 362; Hopkins, 1915, U. S. Dept. Agr., Rep. no. 99, p. 24; Blatchley and Leng, 1916, Rhynchophora of North Eastern America, p. 603; Swaine, 1918, Dom. Can. Dept. Agr., Tech. Bull. 14, pl. 9, fig. 43; Blackman, 1922, Miss. Agr. Exp. Sta., Tech. Bull. 11, p. 89; Dodge, 1938, Minn. Agr. Exp. Sta., Tech. Bull. 132, p. 39; Chamberlin, 1939, The Bark and Timber Beetles of North America North of Mexico, p. 304.

Stephanoderes chapuisii Eichhoff, 1871, Berlin Ent. Zeitschr., p. 132; Leconte, 1876, Proc. Amer. Phil. Soc., vol. 15, p. 356; Eichhoff, 1879, Ratio . . . Tomicinorum, p. 143; Eichhoff and Schwarz, 1896, Proc. U. S. Nat. Mus., vol. 18, pp. 608, 610; Hopkins, 1915, U. S. Dept. Agr., Rep. no. 99, p. 24; Blatchley and Leng, 1916, Rhynchophora of North Eastern America, p. 604; Blackman, 1922, Miss. Agr. Exp. Sta., Tech. Bull. 11, p. 90; Chamberlin, 1939, The Bark and Timber Beetles of North America North of Mexico, p. 305.

This species is closely allied to S. *hirsutus* from which the female differs as follows: uniformly convex declivity; declivital pubescence of very short scales and sparse rows of long, slender, interstrial hair; strial punctures smaller and less deeply impressed; interstrial punctures usually smaller, more abundant and confused; and the area behind the summit more granulate. The male is distinguished from the male of S. *hirsutus* by: a more convex declivity; presence of rather abundant, short, scalelike setae on the declivity; more slender, less abundant, declivital bristles; and the weakly impressed first and second declivital striae. The absence of scalelike setae on the pronotum and the presence of interspacial rows of pointed, hairlike setae on the elytra of both sexes distinguish S. *dissimilis* and S. *hirsutus* from other North American *Stephanoderes*.

Female: Length 1.6-2.4 mm., 2.30 times as long as wide, body color black, antennae and legs usually testaceous.

Frons evenly convex above, more nearly flattened below, finely aciculate; punctures of moderate size, depth, and density. Eye emarginate; finely granulate. Antennal club longer than scape, about 1.37 times as long as wide; the first suture procurved, the second and third bisinuate.

Pronotum about 0.85 times as long as wide; two rather large contiguous teeth on anterior margin, and about 10 to 16 large, distinct asperities between summit and anterior margin; summit rather high, located behind middle; posterior and lateral areas with coarse, close, deep punctures, becoming granulate-punctate behind summit. Pubescence consisting of moderately abundant hair of medium length.

Elytra shining; striae slightly impressed, interstriae usually about one and one-half times as wide as striae (variable); strial punctures smaller, and interstrial punctures usually smaller, more abundant and more confused than in S. *hirsutus*. Declivity steep, convex; striae more strongly impressed than on disc, the punctures usually less distinct; interspaces two, three and nine more convex than the others. Elytral vestiture consisting of sparse rows of long, pointed, interstrial bristles, each shorter than the distance between rows of bristles; and short, abundant, scalelike, interspacial setae; minute strial hair may be visible. Declivital vestiture more abundant and more prominent; the disc often glabrous as a result of wear.

Male: Similar to the female except: length 1.3-1.5 mm., 2.0 times as long as wide; eye reduced in size, about one-half as large as in female; antennal club more slender; funicle usually four-segmented; summit of pronotum higher; asperities narrower; anterior margin of pronotum usually without teeth, although one or two teeth may be present; elytral striae and strial punctures less distinct; and elytral vestiture somewhat longer.

Type Locality: North Carolina.

Hosts: Acer rubrum, Carya spp., *Cercis canadensis, Fagus grandifolia caroliniana, Ficus* sp., *Kalmia latifolia, Quercus* spp., *Ocotea catesbyana, Prunus* sp., *Pyrus* sp., *Rhamnus lanceolata, Sassafras albidum,* and *Vitis* spp.

Distribution: The United States south of the Great Lakes and east of a line connecting southern Minnesota with the lower Rio Grande Valley of Texas, except in Florida south of Lake Okeechobee. Specimens from the following localities have been examined. *Alabama:* Mobile. *Connecticut:* Branford, Hartford, and New Haven. *District of Columbia:* Washington. *Florida:* Biscayne Bay, Dade City, Dunedin, Gainsville, Greenville, Jacksonville, La Belle, Monticello, Oleno State Park, Sanford, Sebring, Seminole, Snead, and Suwannee Springs. *Georgia:* Brunswick. *Illinois:* Lawrenceville. *Kentucky:* Williamsburg. *Louisiana:* Covington. *Maryland:* College Park. *Minnesota:* Olmstead County. *Mississippi:* Lucedale, and Nicholson. *Missouri:* Warrensburg. *New Jersey:* Medford, Phillipsburg, and Prospertown. *New York:* Yaphank. *North Carolina:* Aberdeen, Cherokee, Marston, Monroe, Southern Pines, and Tryon. *Ohio:* Columbus, Franklin County, and Hocking County. *Pennsylvania:* Allegheny, Chambersburg, Easton, Jeanette, Mount Alto, Philadelphia, Pittsburgh, and Wind Gap. *South Carolina:* Awendaw, Edisto Island, and Myrtle Beach. *Tennessee:* Gatlinburg. *Texas:* Columbus, Hidalgo County, Lexington, and College Station.

The type specimen of *Crypturgus dissimilis* is in the Museum of Comparative Zoology.

Stephanoderes rotundicollis Eichhoff

(Figs. 58, 97)

Stephanoderes rotundicollis Eichhoff, 1879, Ratio . . . Tomicinorum, p. 145; Eichhoff and Schwarz, 1896, Proc. U. S. Nat. Mus., vol. 18, p. 608; Hopkins, 1915, U. S. Dept. Agr., Rep. no. 99, p. 24; Blatchley and Leng, 1916, Rhynchophora of North Eastern America, p. 602; Blackman, 1922, Miss. Agr. Exp. Sta., Bull. 11, p. 91; Chamberlin, 1939, The Bark and Timber Beetles of North America North of Mexico, p. 306.

Stephanoderes sculpturatus Eichhoff, 1879, Ratio . . . Tomicinorum, p. 146; Hopkins, 1893, W. Va. Agr. Exp. Sta., Bull. 31, p. 133; Lintner, 1896, N. Y. Rep. 11, p. 270; Eichhoff and Schwarz, 1896, Proc. U. S. Nat. Mus., vol. 18, p. 608; Hopkins, 1915, U. S. Dept. Agr., Rep. no. 99, p. 24; Blatchley and Leng, 1916, Rhynchophora of North Eastern America, p. 603; Chamberlin, 1939, The Bark and Timber Beetles of North America North of Mexico, p. 310.

Hypothenemus erectus, Smith, 1890, Ent. Amer., vol. 6, p. 54; Smith, 1890, Catalogue of the Insects of New Jersey, p. 267; Hopkins, 1893, W. Va. Agr. Exp. Sta., Bull. 31, p. 133; Lintner, 1896, N. Y. Rep. 11, p. 270; Smith, 1900, Catalogue of the Insects of New Jersey, p. 362; Blatchley and Leng, 1916, Rhynchophora of North Eastern America, p. 602.

Stephanoderes quercus Hopkins, 1915, U. S. Dept. Agr., Rep. no. 99, p. 32; Blatchley and Leng, 1916, Rhynchophora of North Eastern America, p. 602; Blackman, 1922, Miss. Agr. Exp. Sta., Tech. Bull. 11, p. 91; Chamberlin, 1939, The Bark and Timber Beetles of North America North of Mexico, p. 306.

The presence of only two teeth on the anterior margin of the pronotum, only 8 to 12 asperities on the pronotum between the summit and the anterior margin, and shorter interspacial scales on the elytral declivity distinguish this species from the closely allied S. *erectus* and S. *castaneus*. It is much smaller than S. *erectus*, and has the pronotum more deeply punctured on the lateral areas than S. *castaneus*. The male is distinguished from the male of S. *castaneus* by a higher summit on the pronotum, and stouter body form; and from S. *erectus* by smaller size, and more distinct strial punctures. These three species are similar in having very short, abundant, interstrial hair- or scalelike setae; rows of long, erect, interspacial bristles flattened and scalelike; a small number (8 to 25) of coarse pronotal asperities, and the presence of scalelike setae on the posterior half of the pronotum.

Female: Length 1.6-1.8 mm., 2.33 times as long as wide; body color black, the antennae and legs may be testaceous.

Frons evenly convex, rarely with a small impression; surface very finely aciculate, the punctures of moderate size, depth and density. Eye emarginate; finely granulate. Antennal club longer than scape, 1.35 times as long as wide; the first suture slightly procurved, the second and third weakly bisinuate.

Pronotum 0.82 times as long as wide, with two rather large contiguous teeth on anterior margin, and about 8 to 12 large, distinct asperities between summit and anterior margin; summit rather high, higher than S. *erectus* or S. *castaneus*, located behind middle; posterior and lateral areas with rather close, small, shallow punctures, usually becoming subgranulate behind summit. Pubescence consisting of rather short, semi-erect, moderately abundant, hairlike setae, becoming intermixed on posterior half with sparse, erect, equally long scalelike setae.

Elytra shining; striae very slightly impressed, punctures small, strongly impressed, separated by about three fourths of their own diameters; interstriae about one and one-half times as wide as striae, punctures minute, abundant and confused. Declivity rather steep, convex. Elytral vestiture consisting of rather abundant, short, recumbent, scale- or hairlike, interstrial setae; and uniserial rows of erect, long, blunt, scalelike bristles, each bristle about three to four times as long as wide, about three-fourths as long on declivity as distance between rows of bristles, somewhat shorter on disc; the disc often glabrous as a result of wear.

Male: Similar to the female except: length 1.3-1.4 mm., 2.0 times as long as wide; eye reduced in size, about one-half as large as in female; antennal club more slender; antennal funicle usually four-segmented; summit of pronotum higher, the asperities narrower; anterior margin of pronotum usually without teeth, although one or two teeth may be present, never more than two; elytral striae and punctures less distinct; and elytral vestiture somewhat longer, particularly on the sides.

Type locality: North America (exact locality not known).

Hosts: Carya spp., *Cercis canadensis, Fagus grandifolia caroliniana, Fraxinus* sp., *Quercus* spp., and *Rhamnus lanceolata.*

Distribution: The United States south and east of a line from Philadelphia, Pennsylvania, through Lawrence, Kansas, to Hidalgo County, Texas, except in Florida south of Snead. Specimens from the following localities have been examined. *Arkansas:* Hot Springs. *Florida:* Snead. *Georgia:* Barnsville. *Kansas:* Kiowa, and Lawrence. *Maryland:* labeled only "Md." *Mississippi:* Trimcane Swamp. *Missouri:* Iron Mountain, and Warrensburg. *New York:* Peekskill. *North Carolina:* Monroe, Southern Pines, and Tryon. *Pennsylvania:* Angora, and Frankford. *Tennessee:* Gatlinburg. *Texas:* Brownsville, Columbus, Dallas, Davis Mountains, Devils River, Hidalgo County, Lexington, Macdona, San Diego, Southmost, and Victoria. *West Virginia:* Berkeley, Dellslow, and Doddridge.

The type specimen of S. *quercus* is in the U. S. National Museum; those of S. *rotundicollis* and S. *sculpturatus* evidently are lost.

Stephanoderes erectus (Leconte)

(Figs. 59, 98)

Hypothenemus erectus Leconte, 1876, Proc. Amer. Phil. Soc., vol. 15, p. 356.

Stephanoderes erectus, Eichhoff and Schwarz, 1896, Proc. U. S. Nat. Mus., vol. 18, p. 608; Hopkins, 1915, U. S. Dept. Agr., Rep. no. 99, p. 24; Chamberlin, 1939, The Bark and Timber Beetles of North America North of Mexico, p 310; Schedl, 1940, An. Esc. Nac. Cienc. Biol. (Mexico), vol. 1, p. 342.

Stephanoderes brunneicollis Hopkins, 1915, U S. Dept. Agr., Rep. no. 99, p. 33; Chamberlin, 1939, The Bark and Timber Beetles of North America North of Mexico, p. 310.

A large species allied to S. *rotundicollis* and S. *castaneus.* From S. *rotundicollis* it may be distinguished by larger size; longer interstrial bristles on the declivity; smaller strial punctures; wider interspaces; more abundant pronotal asperities; and presence of four teeth on the anterior margin of the pronotum. It is separated from S. *castaneus* by: larger size; more narrow interspacial bristles on the declivity; more numerous punctures on the lateral areas of the pronotum; and less abundant, larger, pronotal asperities. These three species are similar in having very short, abundant, interstrial, hair- or scalelike setae; rows of long interspacial bristles, each bristle flattened and scalelike; a small number (8 to 25) of coarse pronotal asperities; and scalelike setae present on the posterior half of the pronotum.

Female: Length 1.8-2.0 mm., 2.36 times as long as wide; body color black, the antennae and legs may be testaceous.

Frons convex above, somewhat flattened below, very finely aciculate, with small, shallow punctures of moderate abundance. Eye emarginate; finely granulate. Antennal club longer than scape, 1.54 times as long as wide; the first suture slightly procurved, the second and third bisinuate.

Pronotum 0.82 times as long as wide; four contiguous teeth on anterior margin, the median pair much larger; about 15 to 20 large, distinct asperities between summit and anterior margin; summit not as high as in S. *rotundicollis,* located at middle; posterior and lateral areas with rather close, small, shallow punctures, usually becoming subgranulate behind summit. Pubescence consisting of rather short, semi-recumbent, moderately abundant, hairlike setae, intermixed on posterior half with sparse, blunt, equally long (or longer), scalelike setae.

Elytra shining; striae distinctly impressed, the punctures small, separated by slightly less than their own diameters; interstriae about two and one-half times as wide as striae, the punctures small, abundant and confused. Declivity not as steep as in S.

rotundicollis or S. *castaneus,* convex. Elytral vestiture consisting of rather abundant, short, scale- or hairlike, interspacial setae; and uniserial rows of long, blunt, scalelike bristles, each bristle on the declivity about four to six times as long as wide, and about as long as the distance between rows of bristles, becoming shorter on the disc; the disc often glabrous as a result of wear.

Male: Similar to the female except: length 1.5-1.7 mm., 2.0 times as long as wide; eye reduced in size about one-half as large as in female; antennal club more slender; funicle usually four-segmented; summit of pronotum higher, the asperities narower; anterior margin of pronotum usually with four teeth as in female, although the lateral pair may be absent; elytral striae and punctures less distinct; and elytral vestiture somewhat longer, particularly on the sides.

Type locality: Round Mountain, Texas.

Hosts: Acacia sp., *Celtis laevigata, Ficus* sp., and *Prosopis* sp.

Distribution: Southern Texas. Specimens from the following localities have been examined. *Texas:* Brownsville, Corpus Christi, Davis Mountains, Hidalgo County, Montell, Round Mountain, San Diego, Southmost, and Victoria.

The type specimen of *Hypothenemus erectus* is in the Museum of Comparative Zoology; that of S. *brunneicollis* is in the U. S. National Museum.

Stephanoderes castaneus, new species

(Figs. 21, 60, 99)

The more numerous, somewhat smaller pronotal asperities; the rougher, less distinctly punctured posterolateral areas of the pronotum; and the lighter body color distinguish this species from its nearest allies, S. *rotundicollis* and S. *erectus.* The female also differs from S. *rotundicollis* by the presence of four teeth on the anterior margin of the pronotum; and from S. *erectus* by the smaller size, and narrower bristles on the declivity. The male is similar to the female, but is also distinguished from the male of S. *rotundicollis* by: the summit of pronotum not as high; and the more slender body form. These three species are similar in having very short abundant interstrial hair- or scalelike setae; rows of long interspacial bristles flattened and scalelike; a small number (8 to 25) of coarse pronotal asperities; and the presence of scalelike setae on the posterior half of the pronotum.

The antennal funicle usually is only three-segmented, indicating that this species should not be included in the genus *Stephanoderes;* however, many of the specimens examined have a partial fourth segment with a fifth segment indicated. Because the segmentation of the funicle is rather indefinite, and since the status of the genus *Stephanoderes* (which is based on a five-segmented funicle) is open to question, this species is included in *Stephanoderes.* Other characters of generic value are absent; in fact, S. *castaneus* is rather difficult to separate from S. *rotundicollis.*

Female: Length 1.5-1.8 mm., 2.30 times as long as wide, body color reddish-brown.

Frons evenly convex above, somewhat flattened below, very finely aciculate; the punctures on the lower half moderate in size, depth and density; pubescence inconspicuous. Eye shallowly emarginate; finely granulate. Antennal club as long as scape, 1.39 times as long as wide; the first and second sutures nearly straight, the third procurved and obscure.

Pronotum 0.85 times as long as wide; four contiguous teeth on anterior margin, the median pair large, the lateral pair minute; about 16 to 22 rather large, distinct asperities between the summit and the anterior margin; summit not as high as in S. *erectus,* located at middle; posterior and lateral areas minutely rugulose, and with a few shallow punctures; more granulate behind summit. Pubescence consisting of rather sparse, short hair which is slightly longer in the region of the asperities; the hair intermixed with scalelike setae of equal length on posterior half of pronotum.

Elytra shining; striae scarcely impressed, punctures small and separated by a distance equal to their own diameters (variable); interstriae about two and one-half times as wide as striae, the punctures minute, shallow, rather abundant and confused. Declivity rather steep, convex. Elytral vestiture consisting of moderately abundant, inconspicuous, hair- or scalelike, interspacial setae; and uniserial rows of long, broad, truncate, scalelike, interspacial bristles, each bristle on the declivity about two to three times as long as wide and almost as long as the distance between rows of bristles, more slender on the disc; the disc often glabrous as a result of wear.

Male: Similar to the female except: length 1.3-1.5 mm., 2.16 times as long as wide; smaller in size; stouter; eye reduced in size, about one-half as large as in female; antennal club more slender; antennal funicle three-segmented; anterior margin of the pronotum may have from one to four teeth, or they may be entirely absent; elytral striae and punctures less distinct; and elytral vestiture somewhat longer, particularly on the sides. As many as four teeth may be present on the anterior margin of the pronotum of S. *castaneus*, only two may be present in S. *rotundicollis*.

Type Locality: Homestead, Fla.

Hosts: Abrus precatorius, Achras sapota, Adenanthera pavonina, Annona sp., *Ardisia paniculata, Bauhinia alba, B.* sp., *Bischofia javanica, Cassia fistula, Cinnamomum camphora, Clerodendron squamatum, Coccolobis laurifolia, Dalbergia ecastophyllum, Eugenia buxifolia, Ficus aurea, Grewia asiatica, Lysiloma bahamensis, Ocotea catesbyana, Persea borbonea, P. americana* (Avocado), *Quercus laurifolia, Rhizophora mangle, Rhus leucantha, Salix* sp., *Tectona grandis, Trema floridana,* and *Vitis* spp.

Distribution: Southern Florida. The holotype female, allotype male, and 62 paratypes were collected June 22, 1951; in addition, 80 paratypes were collected at: Everglades National Park, July 6; Key Largo, June 25; Miami, July 6; Perrine, June 24; and Royal Palm Hammock State Park, June 22 (all collected in 1951 by R. D. Price, R. H. and L. D. Beamer, and S. L. Wood).

The holotype, allotype and 44 paratypes are in the Snow Entomological Collections; additional paratypes are in the collections of the U. S. National Museum, Museum of Comparative Zoology, Canadian National Collection, J. N. Knull, T. O. Thatcher, and the author.

Stephanoderes obesus Hopkins

(Figs. 61, 100)

Stephanoderes obesus Hopkins, U. S. Dept. Agr., Rep. no. 99, p. 30.

Of the same size and proportions as S. *setosus* Eichhoff, but the striae and strial punctures are not impressed. The carina more sharply elevated and frontal impression deeper, lateral areas of the pronotum distinctly punctured, anterior margin of the pronotum with four teeth, the bristles on the declivity narrower, and the larger size distinguish this species from the closely related S. *brunneus*. These two species differ from other North American *Stephanoderes* by having a transverse frontal carina below which is a distinctly flattened or slightly concave impression, and by the conspicuous, rather long, recumbent, hairlike, interspacial and strial setae in addition to the usual rows of bristles.

Female: Length 1.55-1.70 mm., 2.28 times as long as wide, body color testaceous to dark brown.

Frons with a slightly concave, rather broad impression occupying about one half of distance between eyes, a prominent dorsally arched transverse carina at its upper limits; coarsely, closely punctured at sides and above, finely, more sparsely punctured in impression; sparse, rather short bristles cover the area between the transverse carina and epistoma. Eye very broadly, shallowly emarginate; finely granulate. Antennal club not as long as scape, 1.30 times as long as wide, the sutures straight.

Pronotum 0.88 times as long as wide; with four rather widely spaced teeth on anterior margin (irregularly spaced), the median pair smaller; about 18 to 24 large, distinct asperities between summit and anterior margin; summit rather high, similar to S. *castaneus*, located slightly behind middle; posterior and lateral areas covered with close, rather coarse, shallow punctures, the punctures becoming deeper and more granulate at summit. Pubescence consisting of rather abundant, short, erect, hairlike setae (somewhat longer anteriorly), intermixed on the posterior half with slightly longer, sparse, scalelike setae.

Elytra shining; striae not impressed, the punctures small, weakly impressed, separated by approximately their own diameters; interstriae about twice as wide as striae, the punctures minute, abundant, and confused. Declivity evenly convex, the striae scarcely evident. Elytral vestiture consisting of short, slender, rather abundant, hairlike setae; and uniserial rows of long, slightly flattened, slender, blunt bristles, each bristle about as long as the distance between rows of bristles, those on the declivity as wide at the middle as at the distal end; discal pubescence usually about as long and as abundant as that of declivity.

Male: Similar to the female except: length 1.4 mm., 2.28 times as long as wide; eye smaller, about one-half as large as in the female; pubescence slightly longer; and marginal teeth of pronotum reduced in size, the two median ones absent in two of the three specimens examined.

Type Locality: Cayamas, Cuba.

Hosts: Bauhinia alba, Conocarpus erecta, Elaeagnus pungens fruitlandi, Ficus aurea, Leucaena glauca, Mangifera indica (Mango), *Ocotea catesbyana, Persea borbonia, Rhizophora mangle, Trema floridana,* and *Vitis* sp.

Distribution: Southern Florida to Cuba. Specimens from the following localities have been examined. *Florida:* Coconut Grove, Delray Beach, Everglades National Park, Homestead, Key Largo, Miami, Paradise Key, Perrine, and Royal Palm Hammock State Park. *Cuba:* Cayamas.

The type specimen of S. *obesus* is in the U. S. National Museum.

Stephanoderes brunneus Hopkins

(Figs. 62, 63, 101)

Stephanoderes brunneus Hopkins, 1915, U. S. Dept. Agr., Rep. no. 99, p. 31; Chamberlin, 1939, The Bark and Timber Beetles of North America North of Mexico, p. 309; Schedl, 1939, An. Esc. Nac. Cienc. Biol. (Mexico), vol. 1, p. 342.

Stephanoderes frontalis Hopkins, 1915, U. S. Dept. Agr., Rep. no. 99, p. 31; Chamberlin, 1939, The Bark and Timber Beetles of North America North of Mexico, p. 309; Schedl, 1939, An. Esc. Nac. Cienc. Biol. (Mexico), vol. 1, p. 342.

The shorter, less sharply elevated transverse carina and shallow frontal impression, the indistinctly punctured, rugulose lateral areas of the pronotum, the presence of only two widely separated teeth on the anterior margin of the pronotum, the greater width of the declivital bristles, and the smaller size distinguish this species from the closely related S. *obesus.* These species differ from other North American *Stephanoderes* by the presence of a transverse frontal carina below which is a distinct, flattened or slightly concave impression; and by the more conspicuous, rather long, recumbent, hairlike interspacial and strial setae in addition to the uniserial rows of bristles.

Female: Length 1.30-1.45 mm., 2.30 times as long as wide, body color dark brown.

Frons with a prominent, transverse carina at upper level of eyes, a shallow, rather narrow, flattened or slightly concave impression below the carina, the impression impunctate or very finely, sparsely punctured; sparse, short, coarse setae cover lower half of frons, becoming longer and more abundant on epistomal margin. Eye very broadly, shallowly emarginate; finely granulate. Antennal club not as long as scape, about 1.32 times as long as wide, the sutures straight.

Pronotum 0.84 times as long as wide; with two large, widely spaced teeth on the anterior margin, rarely with one or two small ones between them; 15 to 20 large, distinct asperities between summit and anterior margin; summit not as high as in S. *obesus,* located slightly behind middle; posterior and lateral areas minutely rugulose, with sparse, fine, indistinct punctures which become deep and subgranulate near the summit. Pubescence consisting of rather abundant, short, erect, hairlike setae (somewhat longer anteriorly), intermixed on the posterior half with slightly longer, sparse, scalelike setae.

Elytra shining; striae not impressed, punctures small and obscure, separated by approximately their own diameters; interstriae minutely rugulose, at least twice as wide as striae, punctures fine and confused. Declivity evenly convex, the striae scarcely evident. Elytral vestiture consisting of short, slender, hairlike setae; and uniserial rows of scalelike bristles, each bristle about as long as the distance between rows of bristles and increasing in width distally; discal pubescence usually about as long and abundant as that of the declivity.

Male: Similar to the female except: length 1.0-1.1 mm., 2.20 times as long as wide; eye reduced in size about one-half as large as in the female; and pubescence longer and more slender, particularly on the sides.

Type Locality: Brownsville, Texas.

Hosts: Acacia belandieri, Albizzia labbekoides, Annona spp., *Ardisia paniculata, Bauhinia* spp., *Berria amonilla, Cajanus cajon, Calonyction aculeatum, Cassia fistula, Celtis laevigata, Coccolobis laurifolia, Condalia obtusifolia, Dalbergia ecastophyllum, Diphysia robinioides, Galactia spiciformis, Gliricidia sepium, Gossypium herbaceum* (Cotton), *Grewia asiatica, Hovenia dulcis, Ichthyomethia communis, Leucaena glauca, Lysiloma bahamensis, Malicocca bijuga, Ocotea catesbyana, Passiflora latifolia, Poinsettia heterophylla, Rhizophora mangle, Salix* sp., *Trema floridana,* and *Vachellia farnesiana.*

Distribution: The Rio Grande valley in Cameron County, Texas, south along the Gulf coast to Vera Cruz, Mexico; in Florida from Delray Beach south to Key West, and Cayamus, Cuba. Specimens from the following localities have been examined. *Florida:* Delray Beach, Everglades National Park, Homestead, Key Largo, Key West, Matacumba Key, Miami, and Sugar Loaf Key. *Texas:* Brownsville, Port Isabel, Southmost, and Thayer. *Cuba:* Cayamus. *Mexico:* Tampico, and Vera Cruz.

The type specimens of S. *brunneus* and of S. *frontalis* are in the U. S. National Museum.

The teeth on the anterior margin of the pronotum vary somewhat geographically; 98 percent of 129 specimens collected at Brownsville, Texas, have two teeth, 2 percent have three teeth; 56 percent of 117 specimens from southern Florida have two, 33 percent have three, and 12 percent have four marginal teeth. Other differences are not apparent.

Stephanoderes interstitialis Hopkins

(Figs. 64, 65, 102)

Stephanoderes interstitialis Hopkins, 1915, U. S. Dept. Agr., Rep. no. 99, p. 28; Blackman, 1922, Miss. Agr. Exp. Sta., Tech. Bull. 11, p. 93; Chamberlin, 1939, The Bark and Timber Beetles of North America North of Mexico, p. 307.
Stephanoderes interpunctus Hopkins, 1915, U. S. Dept. Agr., Rep. no. 99, p. 28; Blackman, 1922, Miss. Agr. Exp. Sta., Tech. Bull, 11, p. 93; Chamberlin, 1939, The Bark and Timber Beetles of North America North of Mexico, p. 307; Schedl, 1940, An. Esc. Nac. Cienc. Biol. (Mexico), vol. 1, p. 342.
Stephanoderes approximatus Hopkins, 1915, U. S. Dept. Agr., Rep. no. 99, p. 29; Blackman, 1922, Miss. Agr. Exp. Sta., Tech. Bull. 11, p. 93; Chamberlin, 1939, The Bark and Timber Beetles of North America North of Mexico, p. 307.
Stephanoderes flavescens Hopkins, 1915, U. S. Dept. Agr., Rep. no. 99, p. 29; Blatchley and Leng, 1916, Rhynchophora of North Eastern America, p. 602; Chamberlin, 1939, The Bark and Timber Beetles of North America North of Mexico, p. 309.
Stephanoderes opacipennis Hopkins, 1915, U. S. Dept. Agr., Rep. no. 99, p. 30; Chamberlin, 1939, The Bark and Timber Beetles of North America North of Mexico, p. 309.
Stephanoderes quadridentatus Hopkins, 1915, U. S. Dept. Agr., Rep. no. 99, p. 30; Blackman, 1922, Miss. Agr. Exp. Sta., Tech. Bull. 11, p. 91; Chamberlin, 1939, The Bark and Timber Beetles of North America North of Mexico, p. 306.

The narrower declivital bristles, the occurrence of hairlike setae along the entire costal margin of the elytra, the shorter frontal impression, the larger size, and the northern distribution (except in the area where they overlap) distinguish this species from the closely related S. *nitidipennis.* These species differ from other North American *Stephanoderes* by the presence of four teeth of equal size on the anterior margin of the pronotum, the narrower declivital bristles, and the occurrence of hairlike setae on at least the anterior half of the costal margin of the elytra.

Female: Length 1.5-1.7 mm., 2.32 times as long as wide, body color dark brown to black.

Frons convex, finely aciculate to coarsely reticulate, with a very short (rather variable within a series) median groove at upper level of eyes; punctures small, scattered; setae sparse, short and inconspicuous above, longer and more prominent near epistoma. Eye shallowly emarginate or sinuate; finely granulate. Antennal club slightly longer than scape, 1.43 times as long as wide, the sutures straight.

Pronotum 0.92 times as long as wide; anterior margin with four teeth of equal size separated from one another by less than their own width, the bases of the median pair frequently contiguous, rarely with one or two additional granules; asperities of moderate size, rather abundant; posterior and lateral areas finely rugose, with a shallow puncture of moderate size at base of each seta in the lateral areas, the punctures becoming granulate dorsally. Pubescence consisting of hairlike setae which are longer in the asperate region, intermixed on the posterior one-half of the pronotum with rather sparse, scalelike setae.

Elytra shining; striae distinctly impressed, the punctures of moderate size, strongly impressed, separated by less than one half their own diameters; interstriae as wide as striae, the punctures small, granulate, evenly spaced in irregular rows; each granule bearing an erect bristle. Declivity steep, convex; striae more deeply impressed than on disc; interspaces more convex with the granules larger than on disc. Elytral vestiture consisting of minute, inconspicuous, hairlike, strial setae; and uniserial rows of conspicuous bristles; the bristles at elytral base short and broad, usually less than three times as long as wide, those on declivity as long as the distance between rows of bristles, narrow, at least five times as long as wide, longer and almost hairlike on the ninth interspace at base of declivity of some specimens.

Male: Similar to the female except: length 1.1-1.2 mm., 2.10 times as long as wide; eye reduced in size, slightly less than one-half as large as in female; one or more of the teeth on anterior margin of pronotum may be absent; declivity not as steep; striae less definite; elytral pubescence much longer and more slender on the disc and sides.

Type locality: Victoria, Texas.

Hosts: Acacia sp., *Acer rubrum, Aesculus* sp., *Albizzia* sp., *Carya* spp., *Cercis canadensis, Diospyros virginiana, Fagus grandifolia caroliniana, Juglans nigra, liquidambar styraciflua, Magnolia* spp., *Morus rubra, Ocotea catesbyana, Persea borbonia, Picea* sp., *Platanus occidentalis, Prosopis* sp., *Quercus* spp., *Rhododendron* sp., *Rhus* spp., *Smilax* sp., and *Vitis* spp.

Distribution: The United States south and east of a line from the lower Rio Grande valley of Texas, through Lawrence, Kansas, to Connecticut, except in Florida south of Lake Okeechobee. Specimens from the following localities have been examined. *Alabama:* Mobile, and Theodore. *Connecticut:* Branford, and Hamden. *District of Columbia:* Washington. *Florida:* Dade City, Dunedin, Gainsville, Jacksonville, La Belle, Monticello, Oleno State Park, Sanford, Sebring, Snead, and Suwannee Springs. *Georgia:* Brunswick. *Illinois:* East St. Louis, and Lawrenceville. *Kansas:* Lawrence. *Kentucky:* Williamsburg. *Louisiana:* Covington, Krotz Springs, and St. Bernard. *Maryland:* Plummers Island. *Mississippi:* Corinth, Meridian, Nicholson, and Vicksburg. *New Jersey:* Hapatcong, and Ramsey. *North Carolina:* Aberdeen, Black Mountains, Cherokee, and Monroe. *Pennsylvania:* Allegheny, Hummelstown, and Wind Gap. *South Carolina:* Awendaw, and Jacksonboro. *Tennessee:* Gatlinburg. *Texas:* Brownsville, Columbus, Dallas, Southmost, and Victoria. *Virginia:* Blacksburg, and Loudoun. *West Virginia:* Morgantown.

The type specimens of S. *interstitialis,* S. *interpunctus,* S. *approximatus,* S. *flavescens,* S. *opacipennis,* and S. *quadridentatus* are in the U. S. National Museum.

Stephanoderes nitidipennis Hopkins

(Figs. 66, 103)

Stephanoderes nitidipennis Hopkins, 1915, U. S. Dept. Agr., Rep. no. 99, p. 29.

Stephanoderes nitidulus Hopkins, 1915, U. S. Dept. Agr., Rep. no. 99, p. 29.

Stephanoderes subopacicollis Hopkins, 1915, U. S. Dept. Agr., Rep. no. 99, p. 30.

The slightly wider declivital bristles, the occurrence of hairlike setae on only the anterior part of the costal margin of the elytra, the longer frontal groove, the smaller size, and the southern distribution distinguish this species from the closely allied S. *interstitialis.* These species differ from other North American *Stephanoderes* by the presence of four teeth of equal size on the anterior margin of the pronotum, the narrower declivital bristles, and the occurrence of hairlike setae on at least the anterior half of the costal margin of the elytra.

Female: Length 1.25-1.55 mm., 2.40 times as long as wide, body dark brown to black.

Frons convex, coarsely reticulate; a narrow median groove extending from upper level of eyes about one half of the distance to epistomal margin; punctures shallow, of moderate size, rather sparse, and inconspicuous. Pubescence short, sparse and inconspicuous above, longer and more conspicuous near epistomal margin. Eye shallowly emarginate; finely granulate. Antennal club as long as scape, about 1.3 times as long as wide; the sutures straight.

Pronotum 0.94 times as long as wide; the anterior margin with four teeth of equal size, separated from one another by less than the basal width of one tooth, the bases of the median pair occasionally contiguous; asperities of moderate size, numerous; posterior and lateral areas with a shallow puncture of moderate size at the base of each seta, those near and behind the summit granulate. Pubescence consisting of hairlike setae which are longer in the asperate region, intermixed on the posterior one half with rather sparse, scalelike setae.

Elytra shining; striae distinctly impressed, the punctures of moderate size, rather deep, separated by less than one half their own diameters; interstriae as wide as striae, the punctures small, evenly spaced in uniserial rows, becoming granulate posteriorly, each puncture bearing an erect bristle. Declivity steep, convex; striae somewhat more deeply impressed; interspaces slightly more convex with the punctures granulate. Elytral vestiture consisting of minute, inconspicuous, hairlike setae and uniserial rows of bristles; the bristles at the elytral base short and broad, less than three times as long as wide, those on the declivity longer and narrower, about four to five times as long as wide, longer and more slender on the ninth interspace at base of declivity, but never hairlike; setae on only the anterior third of costal margin of elytra hairlike, distinctly flattened on the posterior half.

Male: Similar to the female except: length 1.0-1.1 mm., 2.2 times as long as wide; eye reduced in size about one-third as large as in female; one or more teeth on anterior margin of pronotum may be absent; declivity not as steep; striae less definite; elytral pubescence much longer and more slender on the disc and sides.

Type locality: Cayamas, Cuba.

Hosts: Ardisia paniculata, Amerimnon brownei, Candiosperma holacacobum, Dipholis salicifolia, Erythrina sp., *Eugenia buxifolia, Ficus* sp., *Galactia spiciformis, Ichthyomethia communis, Ipomoea cathartica, Ocotea catesbyana, Quercus laurifolia, Salix* sp., *Sida rhombifolia, Torrubia longifolia,* and *Trema floridana.*

Distribution: Florida, from Dade City south to Key West, and Cuba. Specimens from the following localities have been examined. *Florida:* Biscayne, Everglades National Park, Dade City, Homestead, Key Largo, Key West, Matacumba Key, Miami and Plantation Key. *Cuba:* Cayamas.

The type specimens of S. *nitidipennis,* S. *nitidulus,* and S. *subopacicollis* are in the U. S. National Museum.

Stephanoderes rufescens Hopkins

This species was described from specimens collected at Allegheny, Pennsylvania. Of the twenty-five specimens examined, nine bear a host label "Found in Brazil Nut," presumably *Bertholletia excelsa.* Evidently this is a Neotropical species occasionally collected from imported Brazil Nuts. It is more closely allied to S. *nitidipennis* than to any other North American species, but differs as follows: frontal groove much longer and more prominent; pronotal asperities smaller; strial punctures larger and deeper; declivity not as steep; elytral bristles slightly shorter; and the bristles along the costal margin and ninth interspace not noticeably more slender or longer than elsewhere on the elytra.

Stephanoderes squamosus Hopkins

(Figs. 67, 104)

Stephanoderes squamosus Hopkins, 1915, U. S. Dept. Agr., Rep. no. 99, p. 26.

This species is not closely related to any other North American species of the genus, although it is more nearly allied to S. *interstitialis,* S. *nitidipennis,* and S. *niger,* than to others. It is distinguished from all other North American *Stephanoderes* by the more nearly flattened, deeply striate declivity; the distinctly elevated ridge (only in the female) on the lateral margins of the declivity formed by the junction of interspaces five and seven, four and eight, and three and nine; and the broad scalelike interspacial bristles which are as wide at the base as at the apical end.

Female: Length 1.35-1.50 mm., 2.38 times as long as wide; body color black, except the asperate area of the pronotum which may be castaneous, and the legs and antennae which may be testaceous.

Frons convex except flattened near the epistoma; coarsely reticulate, with a small granule at the base of each seta; setae coarse, short, sparse. Eye sinuate to very shallowly emarginate; finely granulate. Antennal club not as long as scape, about 1.4 times as long as wide, the sutures straight.

Pronotum 0.90 times as long as wide; anterior margin with four teeth of equal size separated from one another by a distance less than the basal width of one tooth; asperities rather small, numerous; lateral and posterior areas finely rugose, with a granulate puncture at the base of each scalelike seta near and behind the summit. Pubescence consisting of hairlike setae which are longer in the asperate region, intermixed on the non-asperate area with short, rather broad, scalelike setae.

Elytra shining; striae slightly impressed, the punctures of moderate size, distinctly impressed, separated by less than one half their own diameters; interstriae rugose, as wide as striae, the punctures small, granulate, evenly spaced in uniserial rows, each bearing an erect, scalelike bristle. Declivity rather steep, weakly convex (almost flattened); striae and strial punctures deeply impressed; interspaces strongly convex, granulate; a distinctly elevated ridge on the lateral margin formed by the junction of interspaces five and seven, four and eight, and three and nine. Elytral vestiture consisting of minute, inconspicuous hairlike strial setae, one arising from each puncture; and uniserial rows of scalelike interstrial bristles, one arising from each puncture; bristles at elytral base less than one-third as long as those on declivity; each declivital bristle about three to four times as long as wide, as wide at its base as at its apex, the greatest width near the middle of each scale.

Male: Similar to the female except: length 0.90-1.15 mm., 2.30 times as long as wide; eye reduced in size about one-third as large as in female; one or more of the teeth on anterior margin of pronotum may be absent; declivity not as steep; ridge at lateral margin of declivity absent; and elytral pubescence much longer on disc and sides.

Type Locality: Cayamas, Cuba.

Hosts: Ardisia paniculata, Dipholis salicifolia, Galactia spiciformis, Ichthyomethia communis, Lysiloma bahamensis, Parthenocissus quinquefolia, Pithecellobium unguis-cati, and *Torrubia longifolia.*

Distribution: Southern Florida and the Keys, and Cuba. Specimens from the following localities have been examined. *Florida:* Everglades National Park, Key Largo, and Matacumba Key. *Cuba:* Cayamas.

The type specimen of S. *squamosus* is in the U. S. National Museum.

Stephanoderes niger Hopkins

(Figs. 71, 109)

Stephanoderes niger Hopkins, 1915, U. S. Dept. Agr., Rep. no. 99, p. 31; Chamberlin, 1939, The Bark and Timber Beetles of North America North of Mexico, p. 309; Schedl, 1940, An. Esc. Nac. Cienc. Biol. (Mexico), vol. 1, p. 342.

The larger body size, the longer, more slender, pointed bristles on the ninth interspace at the posterolateral angles of the elytra, and the more deeply impressed declivital striae separate the female of this species from the female of the closely related S. *sparsus.* These two species are distinguished from the allied S. *obscurus,* S. *andersoni,* S. *liquidambarae,* and S. *georgiae* by: a stouter body form; stouter pronotum (about 0.90 times as long as wide); only four (often fewer) teeth on the anterior margin of the pronotum; and the occurrence of granulate punctures on the posterolateral areas of the pronotum.

Female: Lengh 1.4-1.5 mm., 2.26 times as long as wide, body color brown to black.

Frons convex, with a weak transverse impression above the epistoma, and a short, rather wide median groove at upper level of eyes; surface rather coarsely reticulate above and at sides below, the punctures fine, shallow, rather sparse; pubescence fine, short, and inconspicuous above, longer and more conspicuous near the epistoma. Eye broadly, shallowly emarginate; finely granulate. Antennal club as long as scape, 1.44 times as long as wide; the first suture straight, sutures one and two weakly procurved.

Pronotum 0.90 times as long as wide; anterior margin with four teeth of equal size, the median pair usually contiguous, the lateral pair usually separated from the median ones by a distance less than the basal width of one tooth; asperities rather large, about twenty-five in number; lateral areas coarsely reticulate, with sparse, granulate punctures at base of each scale, somewhat more coarsely granulate behind summit. Pubescence consisting of hairlike setae which are longer in the asperate area, intermixed on posterior nonasperate area with scalelike setae slightly longer than adjacent hair.

Elytra shining; striae slightly impressed anteriorly, more strongly impressed posteriorly, the punctures of moderate size, deeply impressed, separated by less than one half their own diameters; interstriae slightly narrower than striae, punctures coarsely granulate, evenly spaced in uniserial rows and each bearing an erect scalelike bristle. Declivity steep, convex; striae more strongly impressed than on disc; interstriae weakly elevated, coarsely granulate. Elytral vestiture consisting of small inconspicuous hairlike strial setae; and uniserial rows of erect scalelike bristles, each bristle on the declivity almost as long as the distance between rows of bristles, one and one-half to two times as long as wide; each bristle longer, more slender (about five times as long as wide) and pointed on the ninth interspace at the posterolateral angles of the elytra; the setae on costal margin of elytra more slender, but not entirely hairlike anteriorly.

Male: Unknown.

Type Locality: Brownsville, Texas.

Hosts: Unknown.

Distribution: The nine specimens at hand are all from Brownsville, Texas. Schedl (1940) adds Tampico, Mexico.

The type specimen of S. *niger* is in the U. S. National Museum.

Stephanoderes sparsus (Hopkins)

(Figs. 73, 74, 110)

Hypothenemus sparsus Hopkins, 1915, U. S. Dept. Agr., Rep. no. 99, p. 20; Blackman, 1922, Miss. Agr. Exp. Sta., Tech. Bull. 11, p. 87; Chamberlin, 1939, The Bark and Timber Beetles of North America North of Mexico, p. 292.

Hypothenemus similis Hopkins, 1915, U. S. Dept. Agr., Rep. no. 99, p. 20; Chamberlin, 1939, The Bark and Timber Beetles of North America North of Mexico, p. 295.

Stephanoderes tridentatus Hopkins, 1915, U. S. Dept. Agr., Rep. no. 99, p. 31; Chamberlin, 1939, The Bark and Timber Beetles of North America North of Mexico, p. 306.

The smaller body size, the more scalelike bristles on the posterior part of the ninth interspace, and the less deeply impressed declivital striae separate this species from S. *niger.* These two species are distinguished from S. *obscurus,* S. *andersoni,* S. *liquidambarae,* and S. *georgiae* by the stouter body form, the shorter pronotum (about 0.90 times as long as wide), the presence of only four (often fewer) teeth on the anterior margin of the pronotum, and the occurrence of granulate punctures on the posterolateral areas of the pronotum.

Female: Length 1.15-1.30 mm., 2.30 times as long as wide, body color dark brown to black.

Frons uniformly convex, with a short, inconspicuous median groove at upper level of eyes; surface coarsely reticulate, punctures minute, inconspicuous; pubescence fine, short, and inconspicuous above, longer and more conspicuous near epistoma. Eye broadly sinuate, not emarginate; finely granulate. Antennal club longer than scape, 1.55 times as long as wide, the sutures straight.

Pronotum 0.88-0.90 times as long as wide; anterior margin with four teeth of equal size, frequently one or two teeth missing, the spacing close, usually irregular; lateral areas coarsely reticulate, with sparse, granulate punctures at base of each scale, somewhat more coarsely granulate behind summit. Pubescence consisting of hairlike setae which are longer in asperate area, intermixed on posterior non-asperate area with scalelike setae which are slightly longer than adjacent hair.

Elytra shining; striae slightly impressed, the punctures of moderate size, deeply impressed, separated by less than one half their own diameters; interstriae slightly narrower than striae, the punctures coarsely granulate, evenly spaced in uniserial rows, each bearing an erect scalelike bristle. Declivity steep, convex, striae and interstriae as on disc, except the interspacial granules larger. Elytral vestiture consisting of small inconspicuous hairlike strial setae; and uniserial rows of erect scalelike bristles, each bristle on the declivity slightly shorter than the distance between rows of bristles, and one and one-half times as long as wide, only slightly longer, but still scalelike laterally; the setae on the costal margin of the elytra more slender, but not entirely hairlike anteriorly.

Male: Unknown.

Type Locality: Columbus, Texas.

Hosts: Celtis pallida, and *Rhamnus* sp.

Distribution: Southeastern Texas to Mississippi. Specimens from the following localities have been examined. *Mississippi:* Natchez. *Texas:* Brownsville, Columbus, Hidalgo County, Karnes City, Lexington, and San Diego.

The type specimens of *H. sparsus, H. similis,* and *S. tridentatus* are in the U. S. National Museum.

Stephanoderes obscurus (Fabricius)

(Figs. 68, 105)

Hylesinus obscurus Fabricius, 1801, Systema Eleuth., vol. 2, p. 395.

Stephanoderes obscurus, Eggers, 1929, Wien Ent. Ztg., vol. 56, p. 50; Schedl, 1939, Münch. Ent. Gesellschaft, vol. 29, p. 564; Schedl, 1940, Arb. morph. tax. Ent., vol. 7, p. 206.

Cryphalus hispidulus Leconte, 1868, Trans. Amer. Ent. Soc., vol. 2, p. 156; Eichhoff, 1879, Ratio . . . Tomicinorum, p. 136.

Hypothenemus hispidulus, Leconte, 1876, Proc. Amer. Phil. Soc., vol. 15, p. 355; Schwarz, 1878, Proc. Amer. Phil. Soc., vol. 17, p. 468; Hamilton, 1888, Trans. Amer. Ent. Soc., vol. 16, p. 158; Smith, 1890, Ent. Amer., vol. 6, p. 54; Blandford, 1894, Insect Life, vol. 6, p. 263; Hamilton, 1894, Trans. Amer. Ent. Soc., vol. 21, p. 406; Eichhoff and Schwarz, 1896, Proc. U. S. Nat. Mus., vol. 18, pp. 608, 610; Smith, 1900, Catalogue of the Insects of New Jersey, p. 362; Blandford, 1904, Biol. Centr. Amer., Coleoptera, vol. 4, pt. 6, p. 230; Hopkins, 1915, U. S. Dept. Agr., Rep. no. 99, p. 13; Blatchley and Leng, 1916, Rhynchophora of North Eastern America, p. 596; Chamberlin, 1939, The Bark and Timber Beetles of North America North of Mexico, p. 289.

Stephanoderes hispidulus, Currie, 1905, U. S. Dept. Agr., Bull. No. 53, pp. 7, 13.

Stephanoderes seriatus Eichhoff, 1871, Berlin Ent. Zeit., p. 133; Leconte, 1876, Proc. Amer. Phil. Soc., vol. 15, p. 356; Eichhoff, 1879, Ratio . . . Tomicinorum, p. 158; Hopkins, 1915, U. S. Dept. Agr., Rep. no. 99, p. 22; Blatchley and Leng, 1916, Rhynchophora of North Eastern America, p. 600; Chamberlin, 1939, The Bark and Timber Beetles of North America North of Mexico, p. 303; Schedl, 1949, La Plata Univ. Nac. Inst. Mus. Notas (Zool.), vol. 14, no. 116, p. 35.

Stephanoderes guatemalensis Hopkins, 1915, U. S. Dept. Agr., Rep. no. 99, p. 26; Schedl, 1940, An. Esc. Nac. Cienc. Biol. (Mexico), vol. 1, p. 242; Schedl, 1940, Arb. morph. tax. Ent., vol. 7, p. 207.

Stephanoderes brasiliensis Hopkins, 1915, U. S. Dept. Agr., Rep. no. 99, p. 26.

Stephanoderes lecontei Hopkins, 1915, U. S. Dept. Agr., Rep. no. 99, p. 27; Blatchley and Leng, 1916, Rhynchophora of North Eastern America, p. 600; Chamberlin, 1939, The Bark and Timber Beetles of North America North of Mexico, p. 305.

The presence of a subtuberculate frontal elevation at the upper level of the eyes, the slight longitudinal concavity of the frons between the elevation and the epistomal margin, the slightly more slender elytral bristles, and the slightly stouter pronotum with six marginal teeth of equal size distinguish the female of this species from the females of S. *andersoni*, S. *liquidambarae*, and S. *georgiae*. These four species are distinguished from other North American *Stephanoderes* by the presence of six teeth on the anterior margin of the pronotum; and the length and width of the pronotum about equal.

Female: Length 1.4-1.6 mm., 2.34 times as long as wide, body color dark brown to black.

Frons convex, distinctly elevated medially (often almost tuberculate) at upper level of eyes; a narrow median groove extending from summit of the elevation about one fourth to three fourths of the distance toward the epistomal margin (variable); indistinctly flattened on lower half producing a slight longitudinal concavity between summit of elevation and epistomal margin; surface coarsely reticulate, with fine, scattered punctures on lower half; pubescence consisting of fine, sparse, short hair which becomes longer and more conspicuous toward the epistomal margin. Eye with a shallow emargination; finely granulate. Antennal club as long as scape, 1.44 times as long as wide; the sutures straight.

Pronotum 0.98 times as long as wide; anterior margin with six teeth of equal size, separated from one another by a distance less than the basal width of one tooth; often with one or two smaller granules lateral to the marginal teeth; asperities rather small, numerous; lateral areas finely rugose, with rather abundant, shallow punctures of moderate size, the punctures become granulate dorsally and to a lesser extent anteriorly. Pubescence consisting of hairlike setae which are longer in the asperate region, intermixed on the non-asperate area with longer, rather broad, scalelike setae.

Elytra shining; striae slightly impressed, the punctures of moderate size, deeply impressed, separated by less than one half their own diameters; interstriae slightly narrower than striae, punctures small, subgranulate, evenly spaced in uniserial rows, each bearing an erect scalelike bristle. Declivity steep, convex; striae impressed slightly more than on the disc; interstrial punctures subgranulate. Elytral vestiture consisting of minute, inconspicuous, hairlike setae; and uniserial rows of erect scalelike bristles, each bristle on the declivity about as long as the distance between rows of bristles and two to three times as long as wide, not noticeably longer laterally; setae on costal margin of elytra hairlike on the anterior one fourth.

Male: Similar to the female except: length 1.0-1.1 mm., 2.2 times as long as wide; eye reduced in size, about one-third as large as in female; one or more teeth on anterior margin of pronotum may be absent; declivity not as steep; striae less definite; elytral pubescence much longer and more slender on disc and sides.

Type Locality: Cuba.

Hosts: Abrus precatorius, Abutilon mollissimum, Achras sapota, Adenanthera pavonina, Albizzia lebbekoides, Aloe vera, Annona spp., *Bauhinia grandiceps, Betula* sp., *Bidens pilosa, Boehmeria scabra, Bucida buceras, Carya* spp., *Cinnamomum camphora, Clerodendron squamatum, Dalbergia ecastophyllum, Diphysia robinioides, Erythrina* sp., *Ficus* sp., *Gelsemium sempervirens, Gliricidia sepium, Grewia asiatica, Ichthyomethia communis, Juglans nigra, Magnolia* spp., *Mangifera indica* (Mango), *Morus rubra, Ocotea catesbyana, Parmentiera edulis, Passiflora latifolia, Persea americana* (Avocado), *Phalocarpus septentrionis, Phaseolus limensis* (Lima Bean), *Platanus occidentalis, Quercus* spp., *Quisqualis indica, Rhizophora mangle, Rhododendron* sp., *Rhus* spp., *Ricinus communis, Salix* sp., *Schleichera trijuga, Sida rhombifolia, Smilax* sp., *Taxodium distichum, Urena* sp., *Verbesina laciniata, Vitis* spp., *Waltheria americana, Yucca* spp., and *Zea mays* (Corn).

Distribution: The United States south and east of a line from the lower Rio Grande Valley of Texas, through Lawrence, Kansas, to New Jersey. Specimens from the following localities have been examined. *Alabama:* Mobile. *Florida:* Delray Beach, Everglades National Park, Homestead, Jacksonville, Key Largo, Key West, La Belle, Miami, Perrine, Sanford, Sebring, and West Palm Beach. *Georgia:* Brunswick, and Riceboro. *Indiana:* Shoals. *Kansas:* Lawrence. *Kentucky:* Cumberland Falls State Park. *Louisiana:* Covington, Creole, and Krotz Springs. *North Carolina:* Cherokee, Marston, Tryon, and Wilmington Beach. *New Jersey:* St. Cloud. *New York:* Mosholu. *Pennsylvania:* Easton, and Swarthmore. *South Carolina:* Awendaw, Jacksonboro, and St. Helena Island. *Tennessee:* Gatlinburg. *Texas:* Boca Chica, Brownsville, Columbus, Donna, Los Indios, and Victoria. *Virginia:* Accomack. *Brazil:* Pernambuco, Santarem, and Vicosa. *Cuba:* Cayamas. *Guatemala:* Trece Aguas. *Puerto Rico:* Corozol, and Rio Piedras. Also Honduras, Mexico, and Panama, the exact locality not recorded.

The type specimens of *S. brasiliensis, S. guatemalensis,* and *S. lecontei* are in the U. S. National Museum, that of *Hypothenemus hispidulus* is in the Museum of Comparative Zoology. The first specimen in Leconte's series of *H. hispidulus* (recognized as the type) belongs to this species; the second, third and fourth specimens are *H. eruditus*. The specimen from Mexico in the Eggers collection at the U. S. National Museum, compared with the type of *Hylesinus obscurus* by Eggers, was used as the basis for this species; this specimen was compared with paratypes of S. *heterolepsis* Costa Lima and found to be distinct. Costa Lima's species is allied to S. *brunneus*.

Specimens from Pennsylvania have virtually no frontal tubercle, but have a rather conspicuous median groove; those from Key West, Florida (and south), have only a slight median groove, but have a rather large frontal tubercle. Series obtained from localities between these points intergrade completely in a north-south cline. To illustrate this cline, series from Cherokee, North Carolina, Homestead and Key West, Florida, and Brownsville, Texas, were selected for study and divided into three classes as follows: first, those with a weakly developed frontal tubercle and a strong, narrow, median groove; second, those with a rather large tubercle and a strong groove; and third, those with a large tubercle and virtually no groove. The results appear in Table 3. Since the few specimens examined from areas north of North Carolina fall into the first class and those from areas south of Key West fall into the third class, it might be concluded that these features of the frons are directly influenced by the climate. However, if this is correct a higher percentage of specimens from Brownsville, Texas, should fall into the

TABLE 3

The frequency distributions of three classes of frontal sculpture in *Stephanoderes obscurus* (Fabricius).

Locality	Percentage with strong tubercle weak groove	Percentage with strong tubercle strong groove	Percentage with weak tubercle strong groove	Number of specimens examined
Cherokee, North Carolina	3	7	90	30
Homestead, Florida........	62	33	4	51
Key West, Florida........	100	0	0	28
Brownsville, Texas..........	16	34	50	32

first class rather than the third. Evidently southern Texas is a region where hybridization of class one and three is occurring, or the factors causing selection in the eastern portion of North America are absent.

Stephanoderes andersoni, new species

(Figs. 69, 106)

The coarsely, closely, deeply punctured frons of this species is unique among North American *Stephanoderes.* In addition the slightly larger, widely spaced marginal teeth of the pronotum distinguish this species from the closely allied S. *obscurus*, S. *liquidambarae*, and S. *georgiae*. These four species are distinguished from other North American *Stephanoderes* by the presence of six teeth on the anterior margin of the pronotum, and the more slender pronotum which is about equal in length and width.

Female: Length 1.5-1.7 mm., 2.45 times as long as wide, body color dark brown.

Frons convex, with a short, indistinct, median impression (sometimes absent), at upper level of eyes; surface covered with conspicuous, coarse, close, deep punctures, except on a rather broad median line between the median impression and the epistomal margin; pubescence consisting of rather sparse, fine hair of medium length on the punctured area. Eye shallowly emarginate; finely granulate. Antennal club longer than scape, about 2.3 times as long as wide; the first suture straight, sutures two and three slightly bisinuate.

Pronotum 1.00 times as long as wide; anterior margin with six teeth of equal size, separated from one another by a distance equal to, or slightly greater than the basal width of one tooth; often with one or two smaller granules lateral to the marginal teeth; asperities rather small, numerous; lateral area with shallow, moderately abundant punctures of medium size, the punctures become granulate dorsally. Pubescence consisting of longer, hairlike setae in asperate region, intermixed posteriorly in non-asperate area with longer, broad, scalelike setae.

Elytra shining; striae slightly impressed, the punctures of moderate size, deeply impressed, separated by less than one half their own diameters; interstriae slightly narrower than striae, punctures small, not granulate, evenly spaced in uniserial rows, each bearing an erect scalelike bristle. Declivity steep, convex; striae as on disc; interstrial punctures not granulate. Elytral vestiture consisting of small, inconspicuous, hairlike strial setae; and uniserial rows of erect scalelike bristles, each bristle on declivity about as long as the distance between rows of bristles, and two to two and one-half times as long as wide, not noticeably longer laterally; the setae on costal margin of elytra more slender, becoming hairlike on anterior one fourth.

Male: Similar to the female except: length 1.3 mm., about 2.2 times as long as wide; eye reduced in size, about one-half as large as in female; one or more teeth on anterior margin of pronotum may be absent; declivity not as steep; striae less definite; elytral pubescence longer and more slender on disc and sides.

Type Locality: Coconut Grove, Florida.

Hosts: Acrocomia vinifera, Bauhinia tomentosa, Gossypium herbaceum, Mucuna sp., *Sida rhombifolia, Tamarindus indica,* and *Thespesia pulpuinea.*

Distribution: Southern Florida, from Miami to Key West, and the Island of St. Croix. The female holotype and three paratypes were collected April 30, 1945; the male allotype and three paratypes at Coconut Grove, March 31. In addition 45 paratypes were collected at Coconut Grove, March 12, 1917, and Sept. 8, 1944 (collector unknown); Key West, July 3, 1951 by R. D. Price, R. H. and L. D. Beamer, and S. L. Wood; and Christiansted, St. Croix (Virgin Islands), March 2, 1941.

The holotype, allotype, and 43 paratypes are in the U. S. National Museum; additional paratypes are in the Snow Entomological Collections, and in the collection of the author.

This species is named for Dr. W. H. Anderson who first recognized it as an undescribed species.

Stephanoderes liquidambarae, new species

(Figs. 70, 107)

This species is closely allied to S. *georgiae.* Since the frons of some variants of these species are virtually identical, the most reliable characters of S. *liquidambarae* for separating it from S. *georgiae* are: pronotum finely punctured and coarsely reticulate, but not granulate-punctate behind the summit; interstrial punctures on the disc fine, not at all granulate; and the declivital bristles somewhat shorter and of greater width. In addition to the frons (of some variants), other features common to these two species are: the lateral pair of teeth on the anterior pronotal margin distinctly smaller in size; and the elytral bristles usually of greater width than in related species.

Female: Length 1.45-1.6 mm., 2.36 times as long as wide, body color black.

Frons convex, with an indistinct, broad, median elevation extending from upper level of eyes to epistomal margin; surface coarsely reticulate above and on sides below, the punctures fine, shallow, and rather sparse; often with an elongate puncture at upper end of the median elevation suggesting a slight median groove; pubescence fine, short, and inconspicuous above, longer and more conspicuous near the epistoma. Eye shallowly emarginate; finely granulate. Antennal club longer than scape, about 2.3 times as long as wide; the first suture straight, sutures two and three slightly bisinuate.

Pronotum 1.00 times as long as wide; anterior margin with six teeth, the lateral pair reduced in size, the four median ones separated from each other by a distance slightly less than the basal width of one tooth, the lateral pair usually more widely spaced; asperities rather small, numerous; lateral and posterior areas with shallow, moderately abundant punctures of rather small size, becoming granulate near summit; the surface coarsely reticulate and punctured in area behind summit. Pubescence consisting of longer hairlike setae in asperate area, intermixed on posterior non-asperate area with broad, scalelike setae slightly longer than adjacent hair.

Elytra shining; striae slightly impressed, the punctures of moderate size, deeply impressed, separated by less than one half their own diameter; interstriae slightly narrower than striae, the punctures small, not granulate, evenly spaced in uniserial rows, each bearing an erect scalelike bristle. Declivity steep, convex; striae and interstriae slightly narrower than on disc; interstrial punctures subgranulate. Elytral vestiture consisting of small, inconspicuous, hairlike strial setae; and uniserial rows of erect scalelike bristles, each bristle on declivity slightly shorter than the distance between rows of bristles, and about one and one-half times as long as wide, not noticeably longer or more slender laterally; the setae on costal margin of elytra more slender, becoming hairlike on anterior one fourth.

Male: Similar to the female except: length 1.0-1.1 mm., 2.20 times as long as wide; eye reduced in size, about one-third as large as in female; one or more teeth on anterior margin of pronotum may be absent; declivity not as steep; striae less definite; elytral pubescence much longer and more slender on disc and sides.

Type Locality: Jacksonboro, South Carolina.

Host: Liquidambar styraciflua.

Distribution: Known from the following localities in the southeastern United States. The female holotype, male allotype, and 51 paratypes were collected July 13. In addition, 16 paratypes were taken at Krotz Springs, Louisiana, June 7; and Sanford, Florida, July 11; all were collected in 1951 by R. D. Price, R. H. and L. D. Beamer, and S. L. Wood.

The holotype, allotype, and 12 paratypes are in the Snow Entomological Collections; additional paratypes are in the U. S. National Museum, and collection of the author.

Stephanoderes georgiae Hopkins

(Figs. 72, 108)

Stephanoderes georgiae Hopkins, 1915, U. S. Dept. Agr., Rep. no. 99, p. 26; Blatchley and Leng, 1916, Rhynchophora of North Eastern America, p. 600; Chamberlin, 1939, The Bark and Timber Beetles of North America North of Mexico, p. 303.

Stephanoderes texanus Hopkins, 1915, U. S. Dept. Agr., Rep. no. 99, p. 26; Blackman, 1922, Miss. Agr. Exp. Sta., Tech. Bull. 11, p. 94; Chamberlin, 1939, The Bark and Timber Beetles of North America North of Mexico, p. 305.

Stephanoderes pini Hopkins, 1915, U. S. Dept. Agr., Rep. no. 99, p. 27; Blatchley and Leng, 1916, Rhynchophora of North Eastern America, p. 600; Chamberlin, 1939, The Bark and Timber Beetles of North America North of Mexico, p. 305.

Stephanoderes salicis Hopkins, 1915, U. S. Dept. Agr., Rep. no. 99, p. 27; Blatchley and Leng, 1916, Rhynchophora of North Eastern America, p. 600; Chamberlin, 1939, The Bark and Timber Beetles of North America North of Mexico, p. 305.

Stephanoderes floridensis Hopkins, 1915, U. S. Dept. Agr., Rep. no. 99, p. 27; Blatchley and Leng, 1916, Rhynchophora of North Eastern America, p. 601; Chamberlin, 1939, The Bark and Timber Beetles of North America North of Mexico, p. 306.

Stephanoderes ficus Hopkins, 1915, U. S. Dept. Agr., Rep. no. 99, p. 28; Blatchley and Leng, 1916, Rhynchophora of North Eastern America, p. 601; Blackman, 1922, Miss. Agr. Exp. Sta., Tech. Bull. 11, p. 94; Chamberlin, 1939, The Bark and Timber Beetles of North America North of Mexico, p. 308.

Stephanoderes soltaui Hopkins, 1915, U. S. Dept. Agr., Rep. no. 99, p. 28; Blatchley and Leng, 1916, Rhynchophora of North Eastern America, p. 601; Chamberlin, 1939, The Bark and Timber Beetles of North America North of Mexico, p. 308.

Stephanoderes lucasi Hopkins, 1915, U. S. Dept. Agr., Rep. no. 99, p. 28; Blackman, 1922, Miss. Agr. Exp. Sta., Tech. Bull. 11, p. 94; Chamberlin, 1939, The Bark and Timber Beetles of North America North of Mexico, p. 308.

Stephanoderes virentis Hopkins, 1915, U. S. Dept. Agr., Rep. no. 99, p. 28; Blatchley and Leng, 1916, Rhynchophora of North Eastern America, p. 601; Chamberlin, 1939, The Bark and Timber Beetles of North America North of Mexico, p. 308.

Stephanoderes pecanis Hopkins, 1915, U. S. Dept. Agr., Rep. no. 99, p. 29; Blatchley and Leng, 1916, Rhynchophora of North Eastern America, p. 601; Chamberlin, 1939, The Bark and Timber Beetles of North America North of Mexico, p. 308.

Hypothenemus robustus Blackman, 1922, Miss. Agr. Exp. Sta., Tech. Bull. 11, p. 88; Chamberlin, 1939, The Bark and Timber Beetles of North America North of Mexico, p. 293.

This species is closely related to S. *liquidambarae,* and also rather closely allied to S. *obscurus* and S. *andersoni.* From the female of S. *liquidambarae* the female may be separated by: distinctly granulate pronotum behind the summit; interstrial punctures on the disc slightly larger and at least indistinctly granulate; and narrower declivital bristles. The male is smaller, has narrower elytral scales, and a less prominent frontal elevation than the male of S. *liquidambarae.* The absence of an elevation at the upper level of the eyes, or of coarse, close, deep punctures on the frons will distinguish it from S. *obscurus* and S. *andersoni.* These four species are distinguished from other North American *Stephanoderes* by the presence of six teeth on the anterior margin of the pronotum, and the more slender pronotum which is about equal length and width.

Female: Length 1.4-1.5 mm., 2.40 times as long as wide, body color black.

Frons convex with the median line very feebly raised and usually with a median groove extending from upper level of eyes a variable distance toward the epistomal margin; surface coarsely reticulate above and on sides below, punctures fine, shallow, rather sparse; pubescence fine, short, and inconspicuous above, longer and more conspicuous near epistoma. Eye shallowly emarginate; fine granulate. Antennal club longer than scape, 1.44 times as long as wide; the first suture straight, sutures two and three slightly bisinuate.

Pronotum 1.00 times as long as wide; anterior margin with six teeth, the lateral pair reduced in size, the four median ones separated from one another by a distance slightly less than the basal width of one tooth, the lateral pair usually more widely spaced; asperities rather small, and numerous; lateral areas with rather abundant, shallow punctures of moderate size, becoming granulate near asperate area and behind summit to base. Pubescence consisting of longer hairlike setae in asperate area, intermixed on posterior non-asperate area with scalelike setae slightly longer than adjacent hair.

Elytra shining; striae slightly impressed, the punctures of moderate size, deeply impressed, separated by less than one half their own diameters; interstriae slightly narrower than striae, the punctures small, subgranulate, evenly spaced in uniserial rows, each bearing an erect scalelike bristle. Declivity steep, convex; striae and interstriae slightly narrower than on disc; interstrial punctures granulate. Elytral vestiture consisting of small, inconspicuous, hairlike, strial setae; and uniserial rows of erect scalelike bristles, each bristle on declivity slightly shorter than the distance between rows of bristles and one and one-half to two and one-half times as long as wide, not noticeably longer laterally; setae on costal margin of elytra more slender, but not entirely hairlike anteriorly.

Male: Similar to the female except: length 0.8-1.0 mm., 2.20 times as long as wide; eye reduced in size, about one third that of female, often with as few as twenty scattered facets; one or more teeth on anterior margin of pronotum may be absent; declivity not as steep; striae less definite; and the elytral pubescence slightly longer and more slender on disc and sides.

Type locality: Georgia.

Hosts: Acacia sp., *Aleurites fordii* (Tung), *Bambusa tulda, Callicarpa* sp., *Carya* spp., *Cercis canadensis, Citrus aurantifolia* (Lime), *Coccolobis laurifolia, Dipholis salicifolia, Erythrina* sp., *Ficus* sp., *Hibiscus moscheutos, Juglans nigra, Magnolia* sp., *Parthenocissus qunquefolia, Philibertella clausa, Pinus* sp., *Pithecellobium guadelupense, Poinsettia heterophylla, Rhizophora mangle, Schleichera trijuga, Tectona grandis, Urena* sp., *Verbesina laciniata,* and *Wisteria* sp.

Distribution: The United States south of a line drawn from the lower Rio Grande valley of Texas, through southern Kentucky to West Virginia. Specimens from the following localities have been examined. *Alabama:* Foley, and Mobile. *Florida:* Brooksville, Coconut Grove, Dunedin, Fort Myers, Gainsville, Hernando County, Homestead, Indian River, Key Largo, Key West, Miami, Monticello, Orlando, Osceola County, Plantation Key, St. Lucie, Sebring, Sugar Loaf Key, and Tampa. *Kentucky:* Cumberland Falls State Park. *Louisiana:* Baton Rouge, Covington, New Orleans, and Tallulah. *Mississippi:* Lucedale, and Maxie. *North Carolina:* Monroe. *South Carolina:* Awendaw, and Charleston. *Texas:* Angleton, Boca Chica, Brownsville, Columbus, Lexington, Rockdale, San Antonio, San Diego, and Sugarland. *West Virginia:* Morgantown.

The type specimens of *S. georgiae, S. texanus, S. pini, S. salicis, S. floridensis, S. ficis, S. soltani, S. lucasi, S. virentis, S. pecanis,* and *Hypothenemus robustus* are in the U. S. National Museum.

Hypothenemus Westwood

Hypothenemus Westwood, 1834, Trans. Ent. Soc. London, vol. 1, p. 34; Erichson, 1836, Wieg. Archiv., vol. 1, p. 61; Eichhoff, 1864, Berl. Ent. Zeitschr., pp. 34, 45, 56; Leconte, 1876, Proc. Amer. Phil. Soc., vol. 15, p. 355; Leconte and Horn, 1883, Coleoptera of North America, p. 517; Gozman, 1885, Rev. d'Ent., vol. 4 p. 278; Eichhoff and Schwarz, 1896, Proc. U. S. Nat. Mus., vol. 18, p. 608; Blandford, 1904, Biol. Centr. Amer., Coleoptera, vol. 4, pt. 6, p. 226; Swaine, 1909, N. Y. State Mus., Bull. 134, p. 116; Hagedorn, 1910, Coleopterorum Catalogus, pars. 4, p. 40; Hagedorn, 1910, Genera Insectorum, fasc. 111, p. 84; Hopkins, 1915, U. S. Dept. Agr., Rep. no. 99, p. 12; Blatchley and Leng, 1916, Rhynchophora of North Eastern America, p. 594; Leng, 1920, Catalogue of the Coleoptera of America North of Mexico, p. 340; Blackman, 1922, Miss. Agr. Exp. Sta., Tech. Bull. 11, p. 82; Costa Lima, 1928, Suppl. Mem. Inst. Oswaldo Cruz, vol. 4, p. 117; Chamberlin, 1939, The Bark and Timber Beetles of North America North of Mexico, p. 288; Schedl, 1939, Rev. Zool. Bot. Afr., vol. 32, p. 380.

Homoeocryphalus Lindemann, 1876, Bull. Mosc., p. 168; Fauvel, 1884, Rev. d'Ent., vol. 3, p. 315.

Adiaeretus Hagedorn, 1909, Deutsche Ent. Zeitschr., p. 744; Hagedorn, 1910, Coleopterorum Catalogus, pars. 4, p. 47; Hagedorn, 1910, Genera Insectorum, fasc. 111, p. 81; Schedl, 1939, Rev. Zool. Bot. Afr., vol. 32, p. 380.

Cosomoderes, Hopkins, 1915, U. S. Dept. Agr., Rep. no. 99, p. 10; Blatchley and Leng, 1916, Rhynchophora of North Eastern America, p. 593; Leng, 1920, Catalogue of the Coleoptera of America North of Mexico, p. 340; Chamberlin, 1939, The Bark and Timber Beetles of North America North of Mexico, p. 287.

Westwood (1834) erected the monobasic genus *Hypothenemus* for his species *H. eruditus,* and described and illustrated a three-segmented antennal funicle as the distinguishing feature. Eichhoff (1879) found this character to be erroneous and placed *Hypothenemus* as a probable synonym of his genus *Stephanoderes.* Subsequent workers such as Reitter (1894) and Hagedorn (1910a, 1910b) recognized both *Hypothenemus* and *Stephanoderes* as distinct, but considered both as subgenera of *Cryphalus.* Hopkins (1915b) gave both *Hypothenemus* and *Stephanoderes* full generic rank and described several related genera.

Following his examination of their type species Fauvel (1884) found *Homoeocryphalus* to be congeneric with *Hypothenemus;* after a comparable study, Schedl (1939b) made *Adiaeretus* a synonym of *Hypothenemus.* My examination of the antenna of *Cosmoderes schwarzi* leaves little doubt that Hopkins' concept of the genus *Cosmoderes* was not that of Eichhoff, and that Hopkins' species belongs to *Hypothenemus.*

The genus *Hypothenemus* is very closely allied to *Stephanoderes* and in many respects the two genera intergrade. It may be distinguished from allied genera by the four-segmented funicle, the antennal club constricted at the partly septate first suture, the fore tibiae with teeth on only the distal one fourth, the elytra rather finely striate, and body size smaller. In addition, the species of *Hypothenemus* can be readily distinguished from the smaller species of *Stephanoderes* by the presence of numerous, short, hairlike, strial and interstrial setae in addition to the uniserial rows of longer scalelike bristles. The smaller North American *Stephanoderes* have only one row of hairlike strial setae between the rows of bristles. The species of *Trischidias* are closely allied to *Hypothenemus* but differ in having the antennal club without a septum, the body very stout, the elytra more coarsely striate, and with the funicle either three-segmented or with a partial fourth segment fused to the club.

Female larger than male, 0.65-1.4 mm. long, 2.34-2.68 times as long as wide; male about 65 percent as large as the female, 2.2-2.4 times as long as wide; body color light brown to black; vestiture consisting of hairlike and scalelike setae.

Frons broad, usually convex, often with a median groove or elevation, rarely with a transverse elevation; punctures and pubescence usually not prominent. Eye shallowly emarginate; finely granulate; the size reduced in the male one half to one third that of the female. Antennal funicle four-segmented in the female, usually three-segmented in the male; segments two, three, and four not increasing in width distally; club elongate, flattened, with three sutures on both sides, the first partly septate, the second and third marked only by setae, smaller and more slender in the male than in the female.

Pronotum 0.85-1.03 times as long as wide; basal margin and posterior one-third of lateral margin with a fine elevated line; asperate in front of summit; one to six teeth on the anterior margin, one or more of these marginal teeth may be absent in the male. Fore tibia with five teeth (rarely four or six) on the distal one-third. Hind tibia slender, with four teeth on the distal margin.

Elytral striae weakly impressed, with rather fine, close, shallow punctures; interstriae usually almost smooth, with a fine, usually granulate puncture at the base of each elytral bristle; declivity rather steep, convex, and without special prominences or impressions. Vestiture consisting of rows of erect, rather long, interspacial, scalelike bristles; and short, recumbent, hairlike, strial and interstrial setae.

Type species: Hypothenemus eruditus Westwood, monobasic.

KEY TO THE SPECIES OF HYPOTHENEMUS

1. Anterior margin of pronotum broadly rounded, normally bearing six teeth; usually larger than 1.1 mm. 2

Anterior margin of pronotum narrowly rounded, slightly produced, normally bearing not more than four teeth, the lateral pair reduced in size; usually smaller than 1.1 mm. 7

2. Posterolateral areas of pronotum rather deeply, coarsely, closely punctured to lateral margin; pronotum slightly longer than wide, summit in front of middle 3

Posterolateral areas of pronotum with punctures shallow, sparse, or absent, particularly near lateral margin; pronotum (except in *beameri*) distinctly wider than long, with summit at or behind middle 4

3. Posterolateral areas of pronotum with smaller, shallow, more widely spaced punctures; mature elytral pubescence white; average size smaller, 1.25 mm.; southern California, *californicus californicus*

   Posterolateral areas of pronotum with larger, closer, deeper punctures; mature elytral pubescence with a slight yellow color; average size slightly larger, 1.35 mm.; southern United States, *californicus tritici*

4. Body slender, usually more than 2.5 times as long as wide; declivital scales slender, more than three times as long as wide . . 5

   Body rather stout, less than 2.4 times as long as wide; declivital scales broad, less than two times as long as wide 6

5. Frons with a broad, subtuberculate elevation above upper level of eyes, the surface coarsely, closely punctured above and to sides of elevation; pronotal teeth larger, the median pair more widely spaced than others; pronotum longer than wide, summit in front of middle; elytral scales more slender, more than five times as long as wide; length 1.2-1.4 mm. . . . . *beameri*

   Frons often with a median elevation or groove, or both, below upper level of eyes, the punctures not as coarse, rather sparse; median pair of pronotal teeth closer, often contiguous; pronotum distinctly wider than long, summit at middle; elytral scales wider, about three to four times as long as wide; length 1.10-1.25 mm. . . . . *eruditus*

6. Frons convex, usually with an indistinct median elevation or groove, or both; body stouter; declivital scales wider, less than one and one-half times as long as wide . . . . *pubescens*

   Frons strongly, broadly impressed between eyes forming a prominent, subcarinate, transverse elevation at their upper level; body more slender; declivital scales narrower, about two times as long as wide . . . . *columbi*

7. Anterior margin of pronotum strongly produced into a single spine; strial punctures obscure; declivital scales wider, about two times as long as wide . . . . *miles*

   Anterior margin of pronotum bearing four teeth; strial punctures rather deeply impressed; declivital scales narrower, about three times as long as wide . . . . *distinctus*

Hypothenemus californicus californicus Hopkins

Hypothenemus californicus Hopkins, 1915, U. S. Dept. Agr., Rep. no. 99, p. 19; Chamberlin, 1939, The Bark and Timber Beetles of North America North of Mexico, p. 294.

Distinguished from its subspecies, *H. californicus tritici*, by the smaller, more widely spaced punctures and granules on the posterior-lateral areas of the pronotum, the white elytral pubescence, and the distinctive mature body color (dark reddish-brown pronotum and black elytra). These subspecies differ from all other

North American *Hypothenemus* by the distinctly, closely punctured, posterolateral areas of the pronotum which extend to the lateral margins.

Female: Length 1.2-1.3 mm., 2.50 times as long as wide, pronotum dark reddish-brown, the elytra black.

Frons convex above, a weak transverse impression below, usually with a rather narrow, often indistinct median elevation extending from upper level of eyes to epistomal margin, frequently with a short rather inconspicuous median groove at its upper end; surface coarsely reticulate, finely, shallowly punctured; pubescence consisting of sparse, fine hair of medium length, inconspicuous except near the epistomal margin. Eye shallowly, narrowly emarginate; finely granulate. Antennal club as long as scape, 1.46 times as long as wide, the sutures straight, the first suture partly septate.

Pronotum 1.03 times as long as wide; anterior margin with six (often five or seven) large teeth, the lateral ones often slightly larger; each tooth separated from the adjacent ones by a distance at least as great as the basal width of one tooth except the occasionally contiguous median pair; summit anterior to middle; posterior and lateral areas rather finely, shallowly, quite closely punctured, those punctures bearing scalelike setae often granulate; the hairlike pubescence shorter and intermixed on the posterior half with longer, equally abundant, scalelike setae.

Elytra shining; striae weakly impressed, the punctures rather small, shallow, separated by less than their own diameters; interstriae as wide as striae, the punctures small, granulate, evenly spaced in uniserial rows, each bearing an erect scalelike bristle. Declivity steep, convex. Elytral vestiture consisting of small, recumbent, sparse, hairlike, strial and interstrial setae; and uniserial rows of erect scalelike bristles, each bristle on the declivity about three to four times as long as wide, about one and one-half times as long as the adjacent hairlike setae.

Male: Similar to the female except: length 0.75-0.85 mm., 2.2 times as long as wide; eye reduced in size, about one-third as large as in female, facets scattered; antennal funicle three-segmented, the club smaller and more slender; one or more marginal teeth of the pronotum usually absent; and pubescence longer and more slender.

Type Locality: Pomona, California.

Hosts: Encelia californica, and *Malvastrum* sp.

Distribution: Southern California. Specimens from the following localities have been examined: Laguna, Pasadena, Pomona, Redondo, and Westwood Hills.

The type specimen of *H. californicus* is in the U. S. National Museum.

Specimens of *H. californicus californicus* and *H. c. tritici* can be distinguished only by examining rather long series of fully mature specimens; those which are not fully colored can be distinguished only with extreme difficulty, if at all. They evidently are geographical representatives of one species and probably will be found to intergrade when specimens from Mexico are available.

Hypothenemus californicus tritici Hopkins

Hypothenemus tritici Hopkins, 1915, U. S. Dept. Agr., Rep. no. 99, p. 19; Chamberlin, 1939, The Bark and Timber Beetles of North America North of Mexico, p. 295.

Hypothenemus thoracicus Hopkins, 1916, *in* Blatchley and Leng, Rhynchophora of North Eastern America, p. 598; Chamberlin, 1939, The Bark and Timber Beetles of North America North of Mexico, p. 294.

This common and widely distributed subspecies of *H. c. californicus* is distinguished by the larger, closer, deeper punctures on the posterolateral areas of the pronotum; the elytral pubescence with a yellow tint; and the mature body color dark brown to almost black. These two subspecies differ from all other North American *Hypothenemus* by the distinctly, closely punctured, posterolateral areas of the pronotum which extend to the lateral margins.

Female: Length 1.0-1.4 mm., 2.50 times as long as wide, body color dark reddish-brown to black.

Frons convex above, a weak transverse impression below, usually with a rather narrow, often indistinct median elevation extending from upper level of eyes to epistomal margin, frequently with a short rather inconspicuous median groove at upper end of the median elevation; surface coarsely reticulate, finely, shallowly punctured; pubescence consisting of sparse, fine hair of medium length, inconspicuous except near the epistomal margin. Eye shallowly, narrowly emarginate; finely granulate. Antennal club as long as scape, 1.46 times as long as wide, the sutures straight, the first suture partly septate.

Pronotum 1.03 times as long as wide; anterior margin with six (often five or seven) large teeth, the lateral ones slightly larger in most specimens, each tooth separated from adjacent ones by a distance at least as great as the basal width of one tooth, except the occasionally contiguous median pair; summit anterior to middle; posterior and lateral areas coarsely, closely, deeply punctured, those punctures bearing scalelike setae often granulate; the hairlike pubescence shorter and intermixed on the posterior half with longer, equally abundant, scalelike setae.

Elytra shining; striae weakly impressed, the punctures rather small, shallow, separated by less than their own diameters; interstriae as wide as striae, the punctures small, granulate, evenly spaced in uniserial rows, each bearing an erect scalelike bristle. Declivity steep, convex. Elytral vestiture consisting of small, recumbent, sparse, hairlike, strial and interstrial setae; and uniserial rows of erect scalelike bristles, each bristle on the declivity about three to four times as long as wide, about one and one-half times as long as the adjacent hairlike setae.

Male: Similar to the female except: length 0.75-0.85 mm., 2.2 times as long as wide; eye reduced in size, about one-third as large as in female, the facets scattered; antennal funicle three-segmented, the club smaller and more slender; one or more marginal teeth of the pronotum usually absent; and pubescence longer and more slender.

Type locality: Dallas, Texas.

Hosts: Aloe vera, Bauhinia alba, Bidens pilosa, Boehmeria scabra, Cajanus cajon, Cappria bifolia, Cinnamomum camphora, Galactia spiciformis, Glycine max (Soy-bean), *Ipomoea cathartica, Iva imbricata, Mangifera indica* (Mango), *Paspalum vaginatum, Philibertella clausa, Poinsettia heterophylla, Quisqualis indica, Salix babylonica, Sida rhombifolia, Triticum aestivum* (Wheat), *Uniola paniculata, Verbena* sp., *Waltheria americana,* and *Yucca* spp.

Distribution: The United States south and east of a line from Brownsville, Texas, through southeastern Kansas, to Washington, D. C. Specimens from the following localities have been examined. *District of Columbia:* Washington. *Florida:* Homestead, Key Largo, Key Vaca, Key West, Long Key, Matacumba Key, Perrine, and Plantation Key. *Kansas:* Wellington. *Kentucky:* Fulton. *Texas:* Boca Chica, Dallas, and Port Arthur. *South Carolina:* Charleston, Isle of Palms, and Pawleys Beach. *Virginia:* Lynchburg.

The type specimens of *H. tritici* and *H. thoracicus* are in U. S. National Museum.

Hypothenemus beameri, new species

This species is perhaps more closely allied to *H. eruditus* than to any other North American species, but differs from this and other species of the genus by the coarsely, closely, deeply punctured frons, the median elevation above the upper level of the eyes, the arrangement of marginal teeth on the pronotum, and the very slender elytral bristles.

Female: Length 1.2-1.4 mm., 2.64 times as long as wide, body color dark brown to almost black.

Frons convex, with a rather broad, subtuberculate, low, median elevation just above upper level of eyes, a rather inconspicuous median ridge continuing from elevation to epistoma; surface coarsely reticulate, punctures coarse, close, deep, except along the median ridge and epistoma; pubescence consisting of sparse, fine hair of medium length, inconspicuous except near the epistomal margin. Eye shallowly, narrowly emarginate; finely granulate. Antennal club longer than scape, 1.46 times as long as wide, the sutures straight, the first suture partly septate.

Pronotum 1.03 times as long as wide; anterior margin with six rather large teeth of equal size, each separated from adjacent ones by a distance at least as great as the basal width of one tooth, except the more widely separated median pair; summit anterior to middle; posterior and lateral areas finely, closely granulate; the hairlike pubescence shorter and intermixed on the posterior half with longer, equally abundant, scalelike setae; a granule at the base of each scale.

Elytra shining; striae weakly impressed, the punctures rather small, shallow, separated by less than their own diameters; interstriae about as wide as striae, the punctures small, granulate, evenly, quite closely spaced in uniserial rows, each bearing an erect scalelike bristle. Declivity steep, convex. Elytral vestiture consisting of small, recumbent, sparse, hairlike, strial setae; and uniserial rows of erect, scalelike bristles, each bristle on the declivity about five times as long as wide, about two times as long as the adjacent hairlike setae.

Male: Similar to the female except: length 0.75-0.95 mm., 2.42 times as long as wide; eye reduced in size, about one-half as large as in female; antennal funicle three-segmented, the club smaller and more slender; one or more marginal teeth of the pronotum may be absent; and pubescence slightly longer.

Type Locality: Homestead, Florida.

Hosts: Annona sp., *Bidens pilosa, Cappris bifolia, Cajanus cajon, Ichthyomethia communis, Iva imbricata, Mangifera indica* (Mango), *Parmentiera edulis, Persea americana* (Avocado), *Philibertella clausa, Poinsettia heterophylla, Sida rhombifolia,* and *Waltheria americana.*

Distribution: Southern Florida, from Homestead to Key West. The female holotype, male allotype, and 19 paratypes were collected June 22. In addition 57 paratypes were collected at Everglades National Park, July 6; Key Largo, June 25; Key West, July 3; Long Key, June 27; Matacumba Key, June 28; and Plantation Key, June 28; all were collected in 1951 by R. D. Price, R. H. and L. D. Beamer, and S. L. Wood.

The holotype, allotype and 12 paratypes are in the Snow Entomological Collections; additional paratypes are in the collections of the U. S. National Museum, T. O. Thatcher, and the author.

Hypothenemus eruditus Westwood

Hypothenemus eruditus Westwood, 1836, Trans. Ent. Soc. London, vol. 2, p. 34; Erichson, 1836, Archiv f. Naturgesch., vol. 2, p. 61; Scudder, 1865, Proc. Boston Soc. Nat. Hist., vol. 10, pp. 13-14; Ferrari, 1867, Die Forst und Baumzuchtschädlichen Borkenkafer, p. 7; Eichhoff, 1879, Ratio . . . Tomicinorum, p. 165; Sharp, 1879, Trans. Ent. Soc. London, p. 102; Fauvel, 1884, Rev. d'Ent., vol. 3, pp. 315, 390; Hubbard, 1887, Ins. Orange, vol. 14, p. 173; Hamilton, 1889, Trans. Amer. Ent. Soc., vol. 16, p. 158; Schwarz, 1889, Proc. Ent. Soc. Wash., vol. 1, p. 139; Smith, 1890, Ent. Amer., vol. 6, p. 54; Schwarz, 1891, Proc. Ent. Soc. Wash., vol. 2, p. 74; Chittenden, 1893, Ins. Life, vol. 5, p. 250; Hopkins, 1893, W. Va. Agr. Exp. Sta., Bull. 31, p. 132; Blandford, 1894, Ins. Life, vol. 6, pp. 261-263; Reitter, 1894, Verh. Naturf. Vereines Brünn, vol. 33, p. 75; Hamilton, 1894, Trans. Amer. Ent. Soc., vol. 21, p. 406; Hamilton, 1895, Trans. Amer. Ent. Soc., vol. 22, pp. 346, 378; Eichhoff and Schwarz, 1896, Proc. U. S. Nat. Mus., vol. 18, p. 608; Lintner, 1896, 11th N. Y. Report, p. 270; Smith, 1900, Catalogue of the Insects of New Jersey, p. 362; Blandford, 1904, Biol. Centr. Amer., Coleoptera, vol. 4, pt. 6, pp. 229, 230; Currie, 1905, U. S. Dept. Agr., Bull. 53, pp. 7, 13; Newbery, 1910, Ent. Mag., vol. 46, p. 83; Schedl, 1940, An. Esc. Nac. Cienc. Biol. (Mexico), vol. 1, p. 342.

Bostrichus areccae Hornung, 1842, Stett. Ent. Zeit., vol. 3, p. 117; Eichhoff, 1879, Ratio . . . Tomicinorum, pp. 165, 166.

Bostrichus boieldieui Perroud, 1864, Ann. Soc. Linn. Lyon, p. 188.

Hypothenemus pruni Hopkins, 1915, U. S. Dept. Agr., Rep. no. 99, p. 16; Blatchley and Leng, 1916, Rhynchophora of North Eastern America, p. 597; Chamberlin, 1939, The Bark and Timber Beetles of North America North of Mexico, p. 294.

Hypothenemus rumseyi Hopkins, 1915, U. S. Dept. Agr., Rep. no. 99, p. 16; Blatchley and Leng, 1916, Rhynchophora of North Eastern America, p. 597; Blackman, 1922, Miss. Agr. Exp. Sta., Tech. Bull. 11, p. 85; Chamberlin, 1939, The Bark and Timber Beetles of North America North of Mexico, p. 290.

Hypothenemus asiminae Hopkins, 1915, U. S. Dept. Agr., Rep. no. 99, p. 16; Blatchley and Leng, 1915, Rhynchophora of North Eastern America, p. 597; Chamberlin, 1939, The Bark and Timber Beetles of North America North of Mexico, p. 291.

Hypothenemus hamamelidis Hopkins, 1915, U. S. Dept. Agr., Rep. no. 99, p. 16; Blatchley and Leng, 1916, Rhynchophora of North Eastern America, p. 597; Chamberlin, 1939, The Bark and Timber Beetles of North America North of Mexico, p. 294.

Hypothenemus punctifrons Hopkins, 1915, U. S. Dept. Agr., Rep. no. 99, p. 18; Blatchley and Leng, 1916, Rhynchophora of North Eastern America, p. 598; Blackman, 1922, Miss. Agr. Exp. Sta., Tech. Bull. 11, p. 86; Dodge, 1938, Minn. Agr. Exp. Sta., Tech. Bull. 132, p. 39; Chamberlin, 1939, The Bark and Timber Beetles of North America North of Mexico, p. 291.

Hypothenemus subelongatus Hopkins, 1915, U. S. Dept. Agr., Rep. no. 99, p. 19; Chamberlin, 1939, The Bark and Timber Beetles of North America North of Mexico, p. 295.

Hypothenemus nigripennis Hopkins, 1915, U. S. Dept. Agr., Rep. no. 99, p. 19; Blatchley and Leng, 1916, Rhynchophora of North Eastern America, p. 598; Blackman, 1922, Miss. Agr. Exp. Sta., Tech. Bull. 11, p. 86; Chamberlin, 1939, The Bark and Timber Beetles of North America North of Mexico, p. 291.

Stephanoderes evonymi Hopkins, 1915, U. S. Dept. Agr., Rep. no. 99, p. 26; Blatchley and Leng, 1916, Rhynchophora of North Eastern America, p. 600; Chamberlin, 1939, The Bark and Timber Beetles of North America North of Mexico, p. 303.

Hypothenemus germari, Blackman, 1922, Miss. Agr. Exp. Sta., Tech. Bull. 11, p. 83; Chamberlin, 1939, The Bark and Timber Beetles of North America North of Mexico, p. 290.

Hypothenemus juglandis Blackman, 1922, Miss. Agr. Exp. Sta., Tech. Bull. 11, p. 88: Chamberlin, 1939, The Bark and Timber Beetles of North America North of Mexico, p. 292.

Hypothenemus citri Ebling, 1935, Pan-Pacif. Ent., vol. 11, p. 21; Chamberlin, 1939, The Bark and Timber Beetles of North America North of Mexico, p. 289.

This is the most common and widely distributed North American species of *Hypothenemus;* it is variable, different clones (?) from a given locality sometimes differing sharply. It is rather closely allied to *H. pubescens,* but has a more slender body form, and longer more slender elytral scales; it is also similar to *H. beameri,* but lacks the short transverse frontal elevation at the upper level of the eyes, and has less distinctly punctured lateral areas of the pronotum and smaller body size. The convex frons, presence of six marginal teeth on the pronotum, and the narrow elytral scales aid in separating it from other species of this genus.

Female: Length 1.10-1.25 mm., 2.35-2.65 times as long as wide, body color dark brown to almost black.

Frons convex above, a weak transverse impression above the epistomal margin, usually with either a rather narrow indistinct, median elevation of variable length between upper level of eyes and epistomal margin, or with a narrow, often indistinct median groove, or with a combination of both; surface coarsely reticulate, and with punctures varying from fine and obscure to rather coarse and deep; pubescence consisting of sparse, fine hair of medium length, inconspicuous except near epistomal margin. Eye sinuate to shallowly emarginate; finely granulate. Antennal club at least as long as scape, 1.43 times as long as wide, the sutures straight, the first suture partly septate.

Pronotum 0.85-0.95 times as long as wide; anterior margin with six (often five or seven) teeth of equal size, each tooth separated from the adjacent ones by a distance at least as great as the basal width of one tooth except the occasionally contiguous median pair; summit at middle; posterolateral areas coarsely reticulate, sparsely granulate and usually with a few rather small, shallow punctures, rather coarsely granulate-punctate behind summit; the hairlike pubescence shorter and intermixed on posterior half with longer, equally abundant scalelike setae.

Elytra shining; striae weakly impressed, the punctures rather small, shallow, separated by less than their own diameters; interstriae as wide as striae, the punctures small, granulate, evenly spaced in uniserial rows, each bearing an erect scalelike bristle. Declivity steep, convex. Elytral vestiture consisting of small, recumbent, sparse, hairlike strial and interstrial setae; and uniserial rows of erect scalelike bristles, each bristle on the declivity about three to four times as long as wide, about one and one-half times as long as the adjacent hairlike setae.

Male: Similar to the female except: length 0.70-0.80 mm., 2.2 times as long as wide; eye reduced in size, about one half as large as in female; antennal funicle three-segmented, the club smaller and more slender; one or more marginal teeth of pronotum usually absent; and pubescence usually longer and more slender.

Type locality: According to Blandford (1904, p. 229), this species was first collected in "England, burrowing in the cover of a book of unknown antecedents."

Hosts: Abrus precatorius, Adenanthera pavonina, Aesculus sp., *Abutilon mollissimum, Albizzia lebbekoides, Aloe vera, Annona* sp., *Asimina triloba, Bauhinia grandiceps, Berria amonilla, Bidens pilosa, Boehmeria scabra, Bucida buceras, Cajanus cajon, Carya* spp., *Celtis laevigata, Cinnamomum camphora, Coccolobis laurifolia, Cornus* sp., *Elaeagnus pungens fruitlandi, Erythrina* sp., *Ficus aurea, Galactia spiciformis, Helianthus* sp., *Hibiscus rosa-sinensis, Ichthyomethia communis, Ipomoea cathartica, Juglans nigra, Liquidambar styraciflua, Magnolia* sp., *Mangifera indica* (Mango), *Morus* spp., *Nyssa sylvatica, Parmentiera edulis, Paspalum vaginatum, Pasiflora latifolia, P. multiflora, Persea americana* (Avocado), *Phalocarpus septentrionis, Philibertella clausa, Phragmites communis, Prunus* sp., *Quisqualis indica, Rhizophora mangle, Ricinus communis, Sambucus canadensis, Sida rhombifolia, Smilax* sp., *Tectona grandis, Trema floridana, Triopteria jamaicensis, Urena* sp., *Verbesina laciniata, Wisteria* sp., and *Yucca* spp.

Distribution: In the United States south and east of a line from southern Texas, through southern Michigan, to New Jersey; and from southern California. Specimens from the following localities have been examined. *California:* Carlsbad, Coranado, Los Angeles, and Orange. *District of Columbia:* Washington. *Florida:* Dade City, Everglades National Park, Homestead, Key Largo, Key West, Long Key, Missouri Key, Monticello, Oleno State Park, Perrine, Plantation Key, Royal Palm Hammock State Park, Sebring, and Sugar Loaf Key. *Georgia:* Richmond Hill, and Savannah. *Illinois:* East St. Louis, and Lawrenceville. *Louisiana:* Boothville, Covington, Creole, Greenwell Springs, Krotz Springs, and Tallulah. *Maryland:* College Park, and Plumers Island. *Michigan:* Jackson County. *Mississippi:* Agricultural College, Call, Meridian, Natchez, Nicholson, Picayune, Port Gibson, and Starkville. *New Jersey:* Trenton. *North Carolina:* Cherokee, and Tryon. *Pennsylvania:* Chambersburg, Lansdoune, and West Park. *South Carolina:* Awendaw, Charleston, Clemson, and Mount Pleasant. *Tennessee:* Gatlinburg. *Texas:* Boca Chica, Brownsville, Karns City, and Victoria. *West Virginia:* Knoxville, and Little Falls.

The type specimens of *H. pruni, H. rumseyi, H. asiminae, H. hamamelidis, H. punctifrons, H. subelongatus, H. nigripennis, Stephanoderes evonymi,* and *H. juglandis* are in the U. S. National Museum. The type of *H. citri* is in the Museum of the California Academy of Sciences.

Hypothenemus pubescens Hopkins

Hypothenemus pubescens Hopkins, 1915, U. S. Dept. Agr., Rep. no. 99, p. 19; Blatchley and Leng, 1916, Rhynchophora of North Eastern America, p. 598; Chamberlin, 1939, The Bark and Timber Beetles of North America North of Mexico, p. 295.

The stouter body form, and the shorter, broad, elytral scales distinguish this species from the allied *H. eruditus.* The absence of a frontal elevation, the presence of six marginal teeth on the pronotum (the median pair sometimes reduced or absent), the broad elytral scales, and the small body size distinguish this species from others of the genus.

Female: Length 1.0-1.1 mm., 2.34 times as long as wide, body color light yellowish-brown.

Frons convex above, a weak transverse impression below, usually with a rather narrow, often indistinct, median elevation extending from upper level of eyes to epistomal margin, frequently with a short rather inconspicuous median groove at its upper end; surface coarsely reticulate, finely, shallowly punctured; pubescence consisting of sparse, fine hair of medium length, inconspicuous except near epistomal margin. Eye sinuate; finely granulate. Antennal club as long as scape, 1.42 times as long as wide, the sutures straight, the first suture partly septate.

Pronotum 0.94 times as long as wide; anterior margin usually with six (often four or five) teeth, the median pair reduced in size, the lateral pair more widely spaced, the distance about equal to the width of one tooth; summit at middle; posterior and lateral areas reticulate with scattered granulate punctures, the granules not more abundant behind summit; the hairlike pubescence shorter and intermixed on posterior half with longer, equally abundant, scalelike setae.

Elytra rather dull; striae not impressed, the punctures fine, shallow, separated by less than their own diameters; interstriae slightly wider than striae, the punctures small, subgranulate, evenly spaced in uniserial rows, each bearing an erect scalelike bristle. Declivity steep, convex. Elytral vestiture consisting of small, inconspicuous, recumbent, hairlike strial, setae; and uniserial rows of erect, broad, scalelike, interstrial bristles, each bristle on the declivity one to one and one-half times as long as wide, about twice as long as the adjacent hairlike setae.

Male: Similar to the female except: length 0.80 mm., 2.2 times as long as wide; eye reduced in size, about one-half as large as in female; antennal funicle three-segmented, the club smaller and more slender; the median pair of marginal teeth on the pronotum absent; pubescence longer and more slender. Only one male observed.

Type Locality: Key West, Florida.

Host: Paspalum vaginatum.

Distribution: Known only from Key Vaca, Missouri Key and Key West, Florida.

The type specimen of *H. pubescens* is in the U. S. National Museum.

Hypothenemus columbi Hopkins

Hypothenemus columbi Hopkins, 1915, U. S. Dept. Agr., Rep. no. 99, p. 18; Chamberlin, 1939, The Bark and Timber Beetles of North America North of Mexico, p. 294.

Hypothenemus abdominalis Hopkins, 1915, U. S. Dept. Agr., Rep. no. 99, p. 18.

Hypothenemus rufopalliatus Hopkins, 1915, U. S. Dept. Agr., Rep. no. 99, p. 18; Blatchley and Leng, 1916, Rhynchophora of North Eastern America, p. 598; Chamberlin, 1939, The Bark and Timber Beetles of North America North of Mexico, p. 294.

Hypothenemus brunneipennis Hopkins, 1915, U. S. Dept. Agr., Rep. no. 99, p. 18.

Hypothenemus amplipennis Hopkins, 1915 U. S. Dept. Agr., Rep. no. 99, p. 19.

This species is readily distinguished from all other North American representatives of the genus by the prominent transverse frontal elevation below which is a rather deep transverse impression, the presence of six teeth on the broadly rounded anterior margin of the pronotum, and the rather broad elytral scales. It is not closely allied to any other species considered here.

Female: Length 1.05-1.25 mm., 2.42 times as long as wide, body color dark brown.

Frons deeply, transversely impressed between eyes and above epistoma, producing a prominent, subcarinate elevation at upper level of eyes, the elevation as long as one half of distance between eyes; surface above and to sides of impression coarsely reticulate and coarsely, closely, deeply punctured, the impression almost smooth except for a few minute, shallow punctures; pubescence consisting of sparse, fine hair of medium length, inconspicuous except near the epistomal margin. Eye very shallowly emarginate; finely granulate. Antennal club about as long as scape, 1.48 times as long as wide, the sutures straight, the first suture partly septate.

Pronotum 0.94 times as long as wide; anterior margin with six rather small teeth, the lateral pair slightly smaller, each tooth separated from adjacent ones by a distance about equal to the basal width of one tooth; summit at middle; posterior and lateral areas granulate-punctate, particularly on the dorsal half; the hairlike pubescence longer and more abundant anteriorly, shorter and intermixed on the posterior half with longer, equally abundant, scalelike setae.

Elytra shining; striae weakly impressed, the punctures distinct, rather small and shallow, separated by less than their own diameters; interstriae as wide as striae, the punctures small, granulate, in uniserial rows, each bearing an erect scalelike bristle or a shorter recumbent hair. Declivity steep, convex. Elytral vestiture consisting of small, recumbent, sparse, hairlike, strial and interstrial setae; and uniserial rows of erect, scalelike, interstrial bristles, each bristle on the declivity about one and one-half to two times as long as wide, very slightly longer than the adjacent hairlike setae.

Male: Similar to the female except: length 0.81 mm., 2.40 times as long as wide; eye reduced in size, about one-half as large as in female; antennal funicle three-segmented, the club smaller and more slender; one or more marginal teeth of the pronotum may be absent; and pubescence slightly longer and more slender.

Type locality: Columbus, Texas.

Hosts: Bauhinia alba, Citrus aurantifolia (Lime), *Carica papaya* (Papaya), *Ficus* sp., *Ichthyomethia communis, Quercus* sp., and *Salix* sp.

Distribution: The Gulf coast from Brownsville, Texas, to Homestead, Florida; and Cuba. Specimens from the following localities have been examined. *Florida:* Everglades National Park, Homestead, and Perrine. *Louisiana:* Creole. *Mississippi:* Nicholson. *South Carolina:* Mount Pleasant. *Texas:* Brownsville, and Columbus. *Cuba:* Cayamas.

The type specimens of *H. columbi, H. abdominalis, H. rufopalliatus, H. brunneipennis,* and *H. amplipennis* are in the U. S. National Museum.

Hypothenemus miles (Leconte)

Cryphalus miles Leconte, 1878, Proc. Amer. Phil. Soc., vol. 17, p. 433; Schwarz, 1878, Proc. Amer. Phil. Soc., vol. 17, p. 468.

Hypothenemus miles, Hopkins, 1915, U. S. Dept. Agr., Rep. no. 99, p. 13; Blatchley and Leng, 1916, Rhynchophora of North Eastern America, p. 596; Chamberlin, 1939, The Bark and Timber Beetles of North America North of Mexico, p. 288.

This unique species differs from all other North American representatives of the genus by the single, median, hornlike prominence on the anterior margin of the pronotum, the more slender body form, and the obscure elytral striae.

Female: Lenth 1.05-1.15 mm., 2.68 times as long as wide, body color dark brown to piceous.

Frons convex, weakly impressed above the epistoma, with an indistinct, broad, median elevation extending from upper level of eyes to epistomal margin; surface rather coarsely reticulate, distinctly, rather sparsely punctured; pubescence consisting of fine, sparse, long, rather conspicuous hair. Eye weakly sinuate; finely granulate. Antennal club about as long as scape, 1.54 times as long as wide, the sutures straight, the first suture partly septate.

Pronotum of about equal length and width; anterior margin medially produced into a single prominent hornlike spine; summit obscure, near middle; posterior and lateral areas with scattered, subgranulate punctures of moderate size, each granule located at the base of a scalelike seta; the hairlike pubescence short, slightly longer anteriorly, intermixed on the posterior half with longer, equally abundant, broad, scalelike setae.

Elytra shining; striae obscure, the punctures fine, shallow, separated by a distance greater than their own diameters; interstriae wider than striae, the punctures fine, granulate, widely spaced, in uniserial rows, each puncture bearing an erect scalelike bristle.

Declivity moderately steep, convex. Elytral vestiture consisting of small, recumbent, sparse, hairlike, strial and interstrial setae; and uniserial rows of erect scalelike bristles, each bristle on the declivity about two times as long as wide, about one and one-half times as long as the adjacent hairlike setae.

Male: Unknown.

Host: Pinus sp.

Distribution: The only specimens examined were from Tampa, Florida, and St. Catherine's Is., Georgia.

The type specimen of *Cryphalus miles* is located in the Museum of Comparative Zoology; however, at the time of my visit both specimens (the first from Tampa, Fla.; the second from Columbus, Tex.) in Leconte's series were missing from their pins. Dr. Darlington recovered a specimen of *H. distinctus* from the floor of the box, presumably it was the Columbus, Texas specimen. Additional specimens from Tampa, Florida, are in the U. S. National Museum.

Hypothenemus distinctus, new species

The more slender body form, deeper strial punctures, and more slender elytral bristles distinguish this species from the similar *Trischidias atoma.* The combination of the slightly produced anterior margin of the pronotum with four marginal teeth, the slender body size, the coarse strial punctures, and the slender elytral bristles is unique among the North American representatives of the genus.

Female: Length 0.9 mm., 2.45 times as long as wide, mature body color dark brown (the teneral type specimen is yellow).

Frons convex, a weak transverse impression just above the epistoma; a narrow median impression extending from upper level of eyes about one-fourth of the distance to epistomal margin; surface rather coarsely reticulate, and with a few minute, inconspicuous punctures; pubescence scarcely evident, consisting of a few fine hairs of medium length. Eye entire; finely granulate. Antennal club about as long as scape, about 1.50 times as long as wide, the sutures almost straight.

Pronotum 0.97 times as long as wide; anterior margin slightly produced, with four subcontiguous teeth, the median pair distinctly larger; summit at middle; posterior and lateral areas smooth, shining, a few shallow punctures posteriorly, a few granules near asperate area; the hairlike pubescence shorter and intermixed on posterior half with longer, sparse, scalelike setae.

Elytra shining; striae slightly impressed, the punctures rather coarse, deep, separated by a distance less than their own diameters; interstriae narrower than striae, the punctures fine, rather coarsely granulate, evenly, widely spaced in uniserial rows, each puncture bearing an erect bristle. Declivity moderately steep, convex. Elytral vestiture consisting of minute, recumbent, hairlike, strial and interstrial, setae; and uniserial rows of erect scalelike bristles, each bristle on the declivity about three times as long as wide.

Male: Unknown.

Type locality: Union, Missouri.

Host: Rhus aromatica.

Distribution: The teneral female holotype and one mature female paratype (with the head missing) were collected July 26, 1951 by R. D. Price, R. H. and L. D. Beamer, and S. L. Wood. The holotype is in the Snow Entomological Collections, the paratype is in the author's collection. A second paratype of uncertain origin is in the Museum of Comparative Zoology (see *H. miles*).

Hypothenemus schwarzi (Hopkins)

Cosmoderes schwarzi Hopkins, 1915, U. S. Dept. Agr., Rep. no. 99, p. 11; Blatchley and Leng, 1916, Rhynchophora of North Eastern America, p. 593; Chamberlin, 1939, The Bark and Timber Beetles of North America North of Mexico, p. 287.

This species is known only from a balsam mount of the antenna of the type specimen. It is clear from the slide and from Hopkins' (1915b, Fig. 1) illustration that the funicle is composed of four segments, although only three are mentioned in the original description. Since the first suture of the club is partly septate and the funicle is four-segmented, and because the body size is very small (1.0 mm.), it is quite clear that this species belongs to the genus *Hypothenemus.* However, the small size, slender body form, presence of four marginal teeth on the pronotum, and the increase in width distally of the funicular segments suggest that this is a species not at present recognized as occurring in Florida, possibly near or synonymous with *H. distinctus.*

Type Locality: Haw Creek, Florida.

Trischidias Hopkins

Trischidias Hopkins, 1915, U. S. Dept. Agr., Rep. no. 99, p. 12; Blatchley and Leng, 1916, Rhynchophora of North Eastern America, p. 594; Leng, 1920, Catalogue of the Coleoptera of America North of Mexico, p. 339; Chamberlin, 1939, The Bark and Timber Beetles of North America North of Mexico, p. 287.

Hopkins (1915) erected the genus *Trischidias* for a single specimen collected at Brunswick, Georgia. The status of this genus is open to question; however, at present *Trischidias* may be distinguished from *Hypothenemus* on the basis of the large, non-septate antennal club and the stout body form, even though the funicle is not always three-segmented. In addition to Hopkins' *T. georgiae, Hypothenemus atomus* and *T. minutissima* also belong to this genus.

Female larger than the male, 0.65-1.10 mm. long, 2.0-2.3 times as long as wide; male about 60 percent as large as the female; body color light brown to black; vestiture consisting of hairlike and scalelike setae.

Frons broad, usually convex, often with a median groove; punctures and pubescence usually not prominent. Eye entire; finely granulate; reduced in the male to about one third the size of that of the female. Antennal funicle three-segmented in the female, often with a partial fourth segment almost completely fused to the club (the type of *T. georgiae* has only three segments as do occasional specimens of *T. atoma* and most specimens of *T. minutissima;* the line of fusion between the fourth segment and the club is usually visible); segment one longer than the combined length of segments two and three; segments two and three of equal width; club rather large, ovate, the sides not constricted, three sutures indicated by rows of setae, no indication of a septum.

Pronotum 0.82-0.91 times as long as wide; basal and the posterior one-third of lateral margin with a fine elevated line; asperate in front of summit, with two to four teeth on anterior margin.

Elytral striae rather weakly impressed, with rather coarse, close, deep punctures; interstriae with a row of punctures, usually subgranulate, each giving rise to an elytral bristle; declivity rather steep, convex, without special prominences or impressions; vestiture consisting of rows of erect, rather long, interspacial scalelike bristles, and short, recumbent, strial and interstrial hairlike setae.

Type Species: Trischidias georgiae Hopkins, monobasic.

KEY TO THE SPECIES OF TRISCHIDIAS

1. Body 2.3 times as long as wide; anterior margin of pronotum normally with four teeth; elytral striae less coarsely punctured; interstriae wider than striae; body and scale color lighter . . . . . . *atoma*

   Body stouter, 2.0 times as long as wide; anterior margin of pronotum normally with two teeth; elytral striae more coarsely punctured; interstriae narrower than striae; body and scale color darker 2

2. Strial punctures not increasing in size posteriorly; declivital interspaces about as wide as on disc, the strial punctures about as large as on disc; length 0.65-0.80 mm. . . . . *minutissima*

   Strial punctures increasing conspicuously in size posteriorly; declivital interspaces less than one-half as wide as striae, the strial punctures larger than on disc; length 1.1 mm. . . . . *georgiae*

Trischidias atoma (Hopkins)

Hypothenemus atomus Hopkins, 1915, U. S. Dept. Agr., Rep. no. 99, p. 15; Blatchley and Leng, 1916, Rhynchophora of North Eastern America, p. 596; Chamberlin, 1939, The Bark and Timber Beetles of North America North of Mexico, p. 293.

Hypothenemus impressifrons Hopkins, 1915, U. S. Dept. Agr., Rep. no. 99, p. 15; Blatchley and Leng, 1916, Rhynchophora of North Eastern America, p. 596; Chamberlin, 1939, The Bark and Timber Beetles of North America North of Mexico, p. 293.

Hypothenemus marylandicae Hopkins, 1915, U. S. Dept. Agr., Rep. no. 99, p. 15; Blatchley and Leng, 1916, Rhynchophora of North Eastern America, p. 596; Blackman, 1922, Miss. Agr. Exp. Sta., Tech. Bull. 11, p. 83; Chamberlin, 1939, The Bark and Timber Beetles of North America North of Mexico, p. 292.

Hypothenemus robiniae Hopkins, 1915, U. S. Dept. Agr., Rep. no. 99, p. 15; Blatchley and Leng, 1916, Rhynchophora of North Eastern America, p. 597; Chamberlin, 1939, The Bark and Timber Beetles of North America North of Mexico, p. 293.

Hypothenemus toxicodendri Hopkins, 1915, U. S. Dept. Agr., Rep. no. 99, p. 15; Blatchley and Leng, 1916, Rhynchophora of North Eastern America, p. 597; Blackman, 1922, Miss. Agr. Exp. Sta., Tech. Bull. 11, p. 83; Chamberlin, 1939, The Bark and Timber Beetles of North America North of Mexico, p. 290.

The more slender body form, presence of four marginal teeth on the pronotum, less coarsely punctured elytral striae, wider interspaces, and lighter body and scale color distinguish this species from the allied *T. minutissima* and *T. georgiae*.

Female: Length 0.75-1.00 mm., 2.32 times as long as wide, body color dark brown.

Frons convex, a weak transverse impression just above the epistoma, a median impression of variable depth and length extending from upper level of eyes toward epistoma; surface coarsely reticulate and with a few minute, inconspicuous punctures; pubescence scarcely evident, consisting of a few fine hairs of medium length. Eye entire; finely granulate. Antennal club large, longer than scape, 1.28 times as long as wide, the sutures straight.

Pronotum 0.91 times as long as wide; anterior margin slightly produced, with four subcontiguous teeth (rarely five or six), the median pair distinctly larger; summit at middle; posterior and lateral areas coarsely reticulate, with a few scattered granules; the hairlike pubescence shorter and intermixed on the posterior half with longer, equally abundant, scalelike setae.

Elytra shining; striae slightly impressed, the punctures fine, distinct, rather shallow, separated by a distance equal to their own diameters; interstriae wider than striae, the punctures small, rather coarsely granulate, evenly spaced in uniserial rows, each bearing an erect scalelike bristle. Declivity moderately steep, convex. Elytral vestiture consisting of minute, recumbent, hairlike, strial, setae; and uniserial rows of broad, erect, scalelike, interstrial bristles, each bristle on the declivity one to one and one-half times as long as wide.

Male: The only male observed was similar to the female except: length 0.53 mm., body stouter (damaged, could not be measured); eye reduced in size, about one-half as large as in female; antennal funicle three-segmented, the club smaller and more slender; and pubescence slightly longer.

Type locality: Morgantown, West Virginia.

Hosts: Acer rubrum, Asimina triloba, Carya spp., *Castanea dentata, Quercus marilandica, Rhododendron* sp., *Rhus toxicodendron, Robinia* sp., *R. pseudo-acacia, Salix* sp., *S. nigra,* and *Ulmus americana.*

Distribution: The United States south and east of a line from Covington, Louisana, through Lawrence, Kansas, to Maryland. Specimens from the following localities have been examined. *Florida:* Sebring. *Kansas:* Lawrence. *Louisiana:* Covington. *Maryland:* Chevy Chase. *Mississippi:* Trimcane Swamp, and Vicksburg. *North Carolina:* Cherokee, and Tryon. *Tennessee:* Gatlinburg. *West Virginia:* Morgantown.

The type specimens of *H. atomus, H. impressifrons, H. marylandicae, H. robiniae,* and *H. toxicodendri* are in the U. S. National Museum.

Trischidias minutissima, new species

The stouter body form, presence of two (rarely four) marginal teeth on the pronotum, the more coarsely punctured elytral striae, narrower interstriae, and darker body and scale color distinguish the female of this species from that of *T. atoma.* It is more closely allied to *T. georgiae,* but differs by the smaller body size, the strial punctures do not increase conspicuously in size posteriorly, and the marginal teeth on the pronotum subcontiguous.

Female: Length 0.65-0.80 mm., 2.00 times as long as wide, body color black, the scales dusky.

Frons convex, a weak transverse impression just above epistoma; a narrow median impression of variable depth and length extending from upper level of eyes toward epistoma; surface coarsely reticulate, a few minute, inconspicuous punctures; pubescence scarcely evident, consisting of a few fine hairs of medium length. Eye entire; finely granulate. Antennal club large, longer than scape, 1.18 times as long as wide, the sutures straight.

Pronotum 0.82 times as long as wide; anterior margin slightly produced, with two subcontiguous teeth, rarely with an additional pair of small granules lateral to the teeth; summit at middle; posterior and lateral areas coarsely reticulate, with a few scattered granules; the hairlike pubescence shorter and intermixed on the posterior half with longer, equally abundant scalelike setae.

Elytra shining; striae slightly impressed the punctures rather large, deep, separated by a distance equal to their own diameters; interstriae distinctly narrower than the striae, the punctures small, evenly spaced in uniserial rows, each coarsely granulate and bearing an erect scalelike bristle. Declivity moderately steep, convex. Elytral vestiture consisting of minute, recumbent hairlike strial, setae; and uniserial rows of dark colored, broad, erect, scalelike, interstrial bristles, each bristle on the declivity one to one and one-half times as long as wide.

Male: Unknown.

Type Locality: Sugar Loaf Key, Florida.

Host: Rhizophora mangle.

Distribution: The female holotype and 59 paratypes were collected July 3, 1951 by R. D. Price, R. H. and L. D. Beamer, and S. L. Wood, from fungus (?) pustules just under the surface of the bark of a broken root.

The holotype and 12 paratypes are in the Snow Entomological Collections; additional paratypes are in the collections of U. S. National Museum, and the author.

Trischidias georgiae Hopkins

Trischidias georgiae Hopkins, 1915, U. S. Dept. Agr., Rep. no. 99, p. 12; Blatchley and Leng, 1916, Rhynchophora of North Eastern America, p. 594; Chamberlin, 1939, The Bark and Timber Beetles of North America North of Mexico, p. 287.

This species is more closely allied to *T. minutissima* than to any other known species; it differs by the larger size, the strial punctures increase in size posteriorly, and the teeth on the anterior margin of the pronotum smaller and more widely separated.

Female: Length 1.1 mm., about 2.00 times as long as wide, body color black.

Frons convex, a weak transverse impression just above epistoma, a short, shallow, median impression between the eyes; surface rather coarsely reticulate, with a few minute, inconspicuous punctures; pubescence scarcely evident, consisting of a few fine hairs of medium length. Eye entire; finely granulate. Antennal club large, longer than scape.

Pronotum with the anterior margin slightly produced, with two teeth separated by the basal width of one tooth; summit at middle; posterior and lateral areas coarsely reticulate, with a few scattered granules; the hairlike pubescence shorter and intermixed on the posterior half with longer, equally abundant, scalelike setae.

Elytra shining; striae slightly impressed, the punctures rather large, deep, separated by a distance equal to one half their own diameters, becoming larger and closer toward the declivity; interstriae distinctly narrower than striae, the punctures small, rather coarsely granulate and evenly spaced in uniserial rows, each bearing an erect scalelike bristle. Declivity moderately steep, convex; strial punctures very coarse, deep, separated by less than one half their own diameters; the interstriae narrow, about one-half as wide as striae. Elytral vestiture consisting of minute, recumbent, hairlike, strial setae; and uniserial rows of rather dark colored, broad, erect, scalelike, interstrial bristles, each bristle on declivity one to one and one-half times as long as wide.

Type Locality: Brunswick, Georgia.

Host: Unknown.

Distribution: Known only from the type specimen which is in the U. S. National Museum.

SPECIES OMITTED

Plesiophthorus striatus (Leconte)

This species was described in the genus *Cryphalus*, then was transferred by Leconte to *Hypothenemus* where it remained until the present time. The type of *C. striatus* was examined and found to belong to the genus *Plesiophthorus* Schedl. It is of the same size and proportions as *P. californicus*, but has a transverse frontal elevation somewhat similar to that of *P. luteolus*.

Cis terminalis (Mannerheim)

Examination of the type specimen of *Bostrichus terminalis* Mannerheim by Mr. G. Stenius, at Helsinki, has shown this species to belong to the genus *Cis* of the family Cisidae, not to the genus *Cryphalus* in which it was treated by Swaine (1918, p. 89).

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Figs. 1-4. Outline drawings of *Stephanoderes dissimilis,* illustrating tribal characteristics, as follows: 1, lateral aspect of a female; 2, dorsal aspect of a female; 3, lateral aspect of a male; 4, dorsal aspect of a male.

Fig. 5. Outline drawing of the posterior parts of *Pseudopityophthorus pubipennis,* comparing tribal characters.

Figs. 6-11. The antennal club of representatives of the North American genera of Cryphalini (females) as follows: 6, anterior face, and 7, posterior face of *Procryphalus utahensis;* 8, anterior face, and 9, posterior face of *Cryphalus populi;* 10, anterior face, and 11, posterior face of *Cryphalomorphus floridensis.*

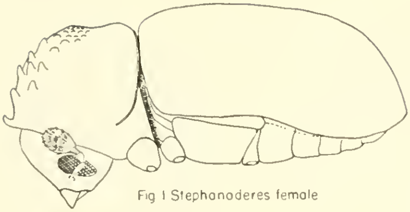


Fig 1 Stephanoderes female

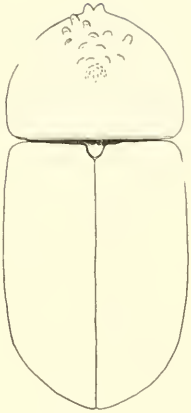


Fig 2 Stephanoderes female

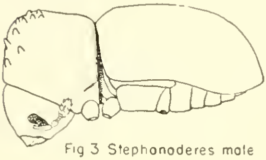


Fig 3 Stephanoderes male

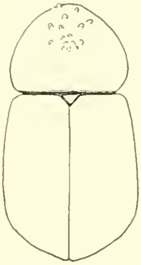


Fig 4 Stephanoderes male

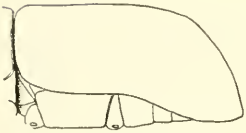


Fig. 5 Pityophthorini

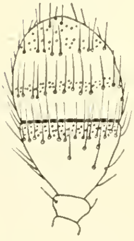


Fig 6 Procryphalus

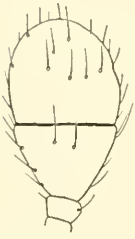


Fig. 7 Procryphalus

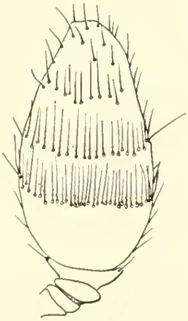


Fig 8 Cryphalus

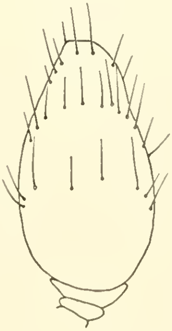


Fig 9 Cryphalus

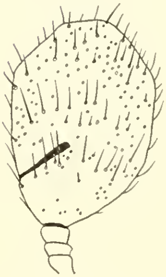


Fig 10 Cryphalomorphus

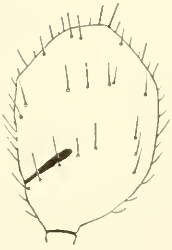


Fig 11 Cryphalomorphus

Figs. 12-24. The antennal club of representatives of the North American genera of Cryphalini (females) as follows: 12, anterior face, and 13, posterior face of *Taenioglyptes pubescens;* 14, anterior face, and 15, posterior face of *Hypocryphalus mangiferae;* 16, anterior face, and 17, posterior face of *Cryptocarenus porosus;* 18, anterior face, and 19, posterior face of *Hypothenemus eruditus;* 20, anterior face of *Trischidias minutissima;* 21, antennal funicle of *Stephanoderes castaneus;* 22, anterior face of female, 23, posterior face of female, and 24, anterior face of male *Stephanoderes dissimilis.*

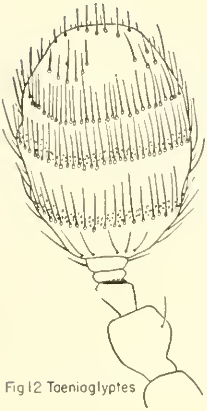


Fig 12 Taenioglyptes

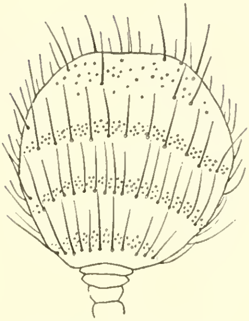


Fig 14 Hypocryphalus

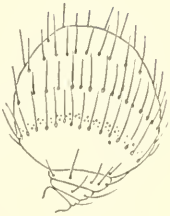


Fig 16 Cryptocarenus

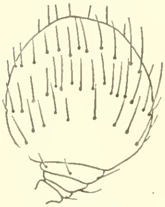


Fig 17 Cryptocarenus

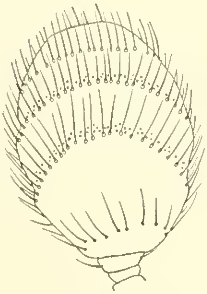


Fig 13 Taenioglyptes

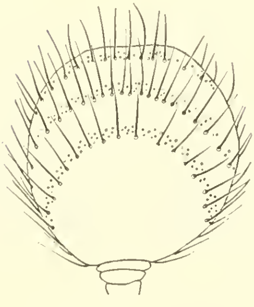


Fig 15 Hypocryphalus

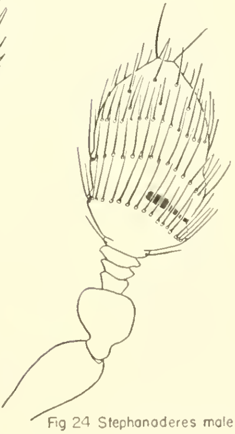


Fig 24 Stephanoderes male

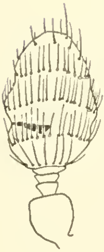


Fig 18 Hypothenemus

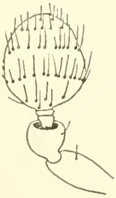


Fig. 20 Trischidias

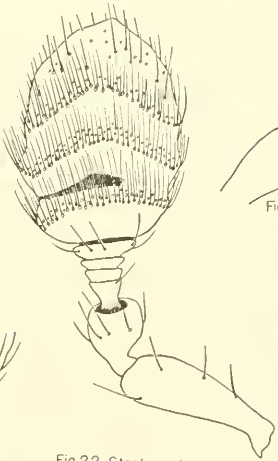


Fig 22 Stephanoderes female

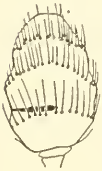


Fig 19 Hypothenemus

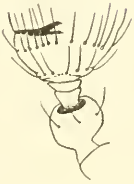


Fig 21 Stephanoderes castaneus

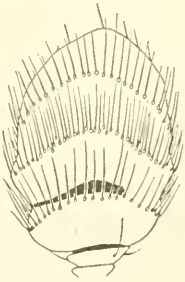


Fig 23 Stephanoderes female

Figs. 25-32. The posterior face of prothoracic tibiae of representatives of the North American genera of Cryphalini (females) as follows: 25, *Procryphalus utahensis;* 26, *Cryphalus populi;* 27, *Cryphalomorphus floridensis;* 28, *Taenioglyptes pubescens;* 29, *Hypocryphalus mangiferae;* 30, *Cryptocarenus porosus;* 31, *Stephanoderes dissimilis;* 32, *Hypothenemus eruditus.*

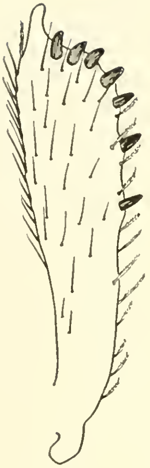


Fig.25 Procryphalus

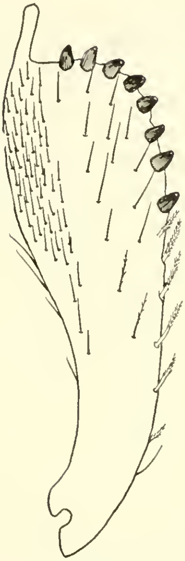


Fig.26 Crypholus

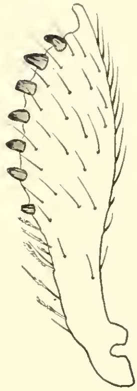


Fig 27 Cryphalomorphus

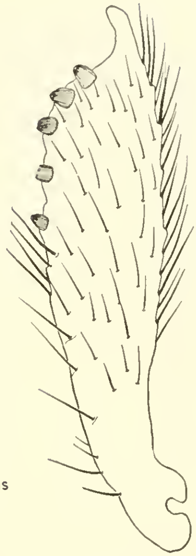


Fig.28 Taenioglyptes

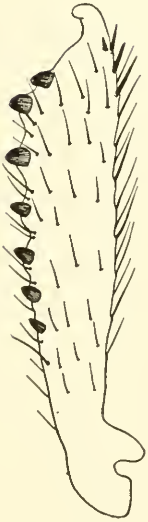


Fig.29 Hypocryphalus

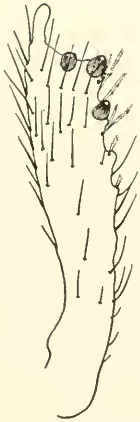


Fig.30 Cryptocarenus

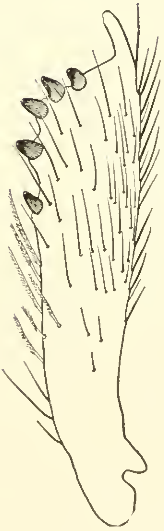


Fig.31 Stephanoderes

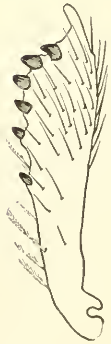


Fig 32 Hypothenemus

Figs. 33-40. The anterior face of metathoracic tibiae of representatives of the North American genera of Cryphalini (females) as follows: 33, *Procryphalus utahensis;* 34, *Cryphalus populi;* 35, *Cryphalomorphus floridensis;* 36, *Taenioglyptes pubescens;* 37, *Hypocryphalus mangiferae;* 38, *Cryptocarenus porosus;* 39, *Stephanoderes dissimilis;* 40, *Hypothenemus eruditus.*

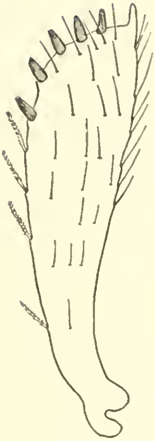


Fig 33 Procryphalus

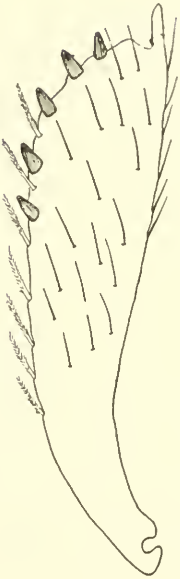


Fig 34 Cryphalus

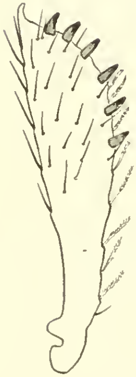


Fig 35 Cryphalomorphus

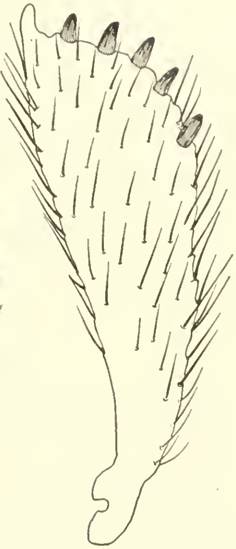


Fig.36 Toenioglyptes

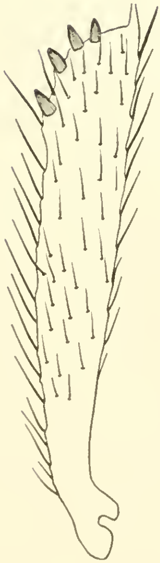


Fig 37 Hypocryphalus

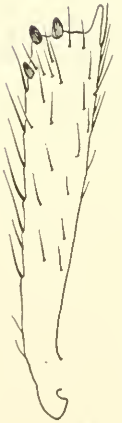


Fig.38 Cryptocorenus

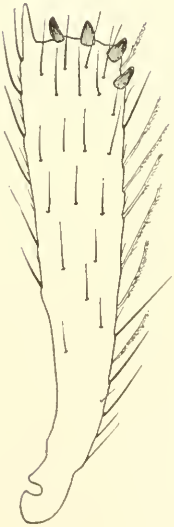


Fig 39 Stephanoderes

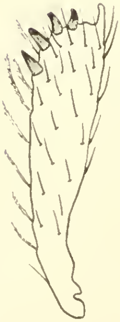


Fig 40 Hypothenemus

Fig. 41. Posterior-dorsal aspect of the seventh and eighth terga of a *Taenioglyptes pubescens* male.

Fig. 42. Posterior-dorsal aspect of the seventh tergum of a *Taenioglyptes pubescens* female.

Figs. 43-84. Outline drawings of the anterior margin of the pronotum of North American Cryphalini (females), from a dorsal and slightly posterior aspect, as follows: 43, *Cryphalus nitidus;* 44, *C. salicis;* 45, *C. populi;* 46, *Procryphalus aceris;* 47, *P. utahensis;* 48, *P. mucronatus;* 49, *Cryphalomorphus floridensis;* 50-52, *Taenioglyptes ruficollis ruficollis,* individual variations from a single series; 53, *Hypocryphalus mangiferae;* 54, *Cryptocarenus porosus;* 55, *C. floridensis;* 56, *Stephanoderes hirsutus;* 57, *S. dissimilis;* 58, *S. rotundicollis;* 59, *S. erectus;* 60, *S. castaneus;* 61, *S. obesus;* 62-63, *S. brunneus,* variations; 64-65, *S. interstitialis,* variations; 66, *S. nitidipennis;* 67, *S. squamosus;* 68, *S. obscurus;* 69, *S. andersoni;* 70, *S. liquidambarae;* 71, *S. niger;* 72, *S. georgiae;* 73-74, *S. sparsus;* 75, *Hypothenemus californicus tritici;* 76, *H. c. californicus;* 77, *H. eruditus;* 78, *H. pubescens;* 79, *H. beameri;* 80, *H. columbi;* 81, *H. distinctus;* 82, *H. miles;* 83, *Trischidias atoma;* 84, *T. minutissima.*

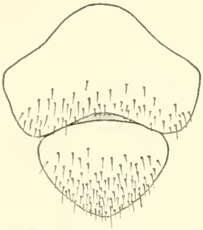


Fig 41 Taenioglyptes male

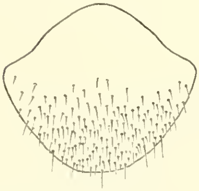


Fig 42 Taenioglyptes female

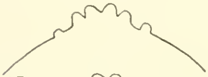


Fig 43

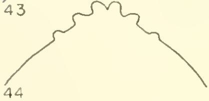


Fig 44

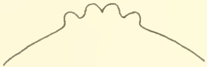
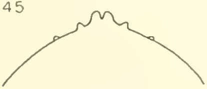


Fig 45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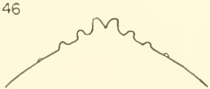
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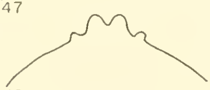
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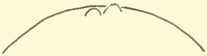
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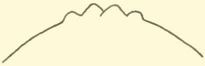
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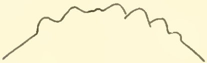
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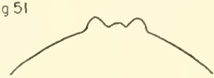


Fig 52

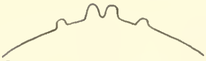
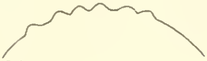


Fig 53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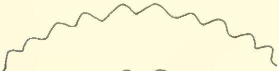
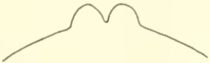


Fig 55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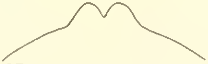
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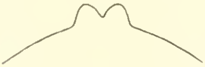
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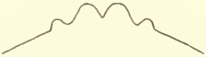
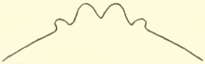


Fig 59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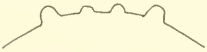
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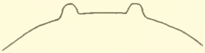
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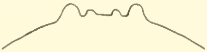
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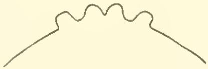
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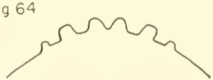
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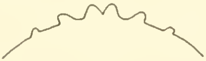
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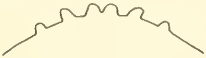
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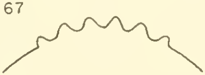
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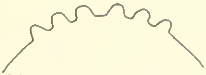
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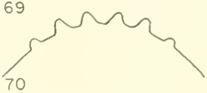
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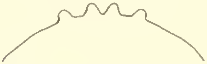
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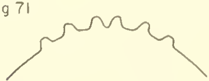
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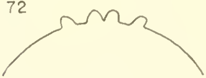
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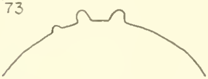
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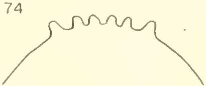
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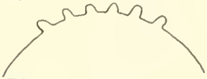
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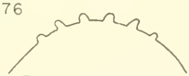
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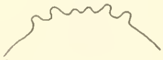
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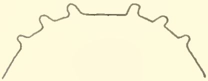
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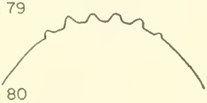
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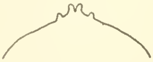
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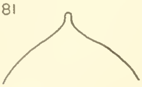
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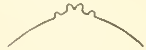
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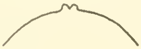
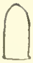


Fig. 84

Figs. 85-120. Outline drawings of an individual interstrial bristle from the second declivital interspace, near the center of the declivity, of North American Cryphalini as follows: 85, *Procryphalus aceris;* 86, *P. utahensis;* 87, *P. mucronatus;* 88, *Cryphalus nitidus;* 89, *C. salicius;* 90, *C. thatcheri;* 91, *C. populi;* 92, *Cryphalomorphus floridensis;* 93, *Cryptocarenus porosus;* 94, *C. floridensis;* 95, *Stephanoderes hirsutus;* 96, *S. dissimilis;* 97, *S. rotundicollis;* 98, *S. erectus;* 99, *S. castaneus;* 100, *S. obesus;* 101, *S. brunneus;* 102, *S. interstitialis;* 103, *S. nitidipennis;* 104, *S. squamosus;* 105, *S. obscurus;* 106, *S. andersoni;* 107, *S. liquidambarae;* 108, *S. georgiae;* 109, *S. niger;* 110, *S. sparsus;* 111, *Hypothenemus californicus californicus;* 112, *H. c. tritici;* 113-114, *H. eruditus;* 115, *H. pubescens;* 116, *H. columbi;* 117, *H. distinctus;* 118, *H. miles;* 119, *Trischidias atoma;* 120, *T. minutissima.*

Fig. 121. The relative frequencies (percentage) of six classes of *Hypothenemus eruditus* specimens occurring in each of four series collected July 10, 1951, at Homestead, Florida, from *Sambucus canadensis* (44 specimens), *Bauhinia grandiceps* (57 specimens), *Hibiscus rosa-sinensis* (38 specimens), and *Tectona grandis* (15 specimens). The six classes are based on the relative width versus length of the bristles on the second declivital interspace as follows: 1, 1.62 or less; 2, 1.63-187; 3, 1.88-2.12; 4, 2.13-2.37; 5, 2.38-2.62; and 6, 2.63 or more times as long as wide.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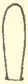
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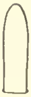
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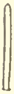
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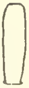
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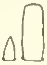
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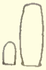
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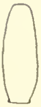
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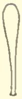
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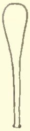
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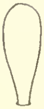
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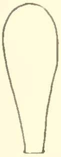
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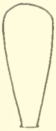
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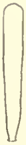
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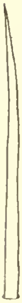
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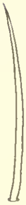
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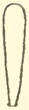
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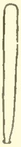
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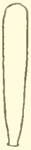
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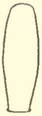
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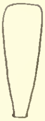
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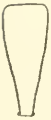
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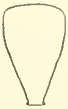
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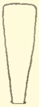
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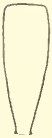
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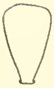
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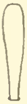
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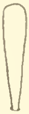
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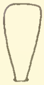
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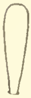
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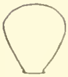
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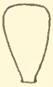
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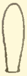
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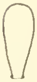
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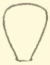
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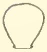
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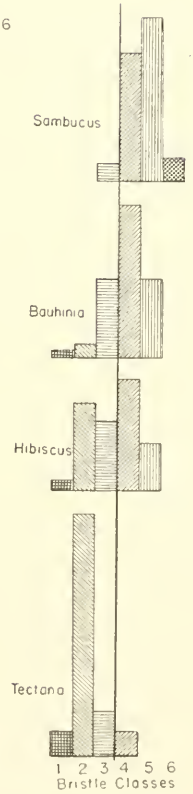

Fig 121 Hypothenemus eruditus

THE UNIVERSITY OF KANSAS
SCIENCE BULLETIN

Vol. XXXVI, Pt. II] July 15, 1954 [No. 16

A Revision of the Tarsonemidae of the Western Hemisphere (Order Acarina)*†

By

Robert E. Beer [1]

Abstract.—The mite family Tarsonemidae was erected in 1877 by Kramer based upon the type genus *Tarsonemus* Canestrini and Fanzago, 1876. The family has been variously placed in the order Acarina by acarologists since that time, but evidence is offered for including the Tarsonemidae in the suborder Trombidiformes, a position recognized by some workers.

The family, formerly represented by two recognized genera, has been further divided so as to include five genera, one of which has been established in this paper to include a species heretofore undescribed. The new genera are *Steneotarsonemus,* with ten included species two of which are new, *Xenotarsonemus,* which is monotypic and *Rhynchotarsonemus* which is also monotypic, this latter genus being established to include a single new species. The old genus, *Tarsonemus* Canestrini and Fanzago, includes seventeen Western Hemisphere species, three of which are here described as new to science. The genus *Hemitarsonemus* Ewing includes three species one of which is new. Descriptions of mites included in this paper, with the single exception of *T. truncatus,* are presented in rather minute detail. The purpose of such a prolix dissertation is to place in the hands of acarologists in other parts of the world a useful tool for identification of tarsonemid mites, and hence characters not at present found to be significant in species differentiation are included with the hope of facilitating further investigations.

An attempt is made to establish phylogenetic relationships of the various groups and species within the groups. Such information as host correlation as well as morphological characteristics are considered in determining these relationships. Included also is a brief dissertation on morphology and terminology of tarsonemid mites as well as the bionomics of typical species.

The most recent revision of the group by Ewing in 1939 has undergone considerable change in this paper. Re-evaluation of the family Tarsonemidae

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* Portions of this paper were submitted to the Division of Entomology and Parasitology and the Graduate School of the University of California in partial fulfillment of the requirements for the degree of Doctor of Philosophy.

† Contribution number 851 from the Department of Entomology of the University of Kansas. Studies augmented by funds from General Research Project 62 of the University of Kansas.

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has led to the separation of certain genera formerly included in the family and their transferral to other families. The family is redefined so as to include only two of Ewing's three genera comprising the subfamily Tarsoneminae. As a result the family here consists of Ewing's subfamily in part, with his remaining two subfamilies being elevated to family rank, an arrangement previously suggested or used in part by some other authors.

Important economic species of tarsonemid mites include the cyclamen mite, broad mite, fern mite, pineapple mite, sugarcane mite and others. The economic importance and control measures for certain species of the family are discussed. Some species, such as the peach bud mite, *Tarsonemus waitei* (Banks), and the species *T. setifer* formerly recognized as pestiferous are here considered as being only secondary invaders of dead or diseased plant tissues. To the list of economically important mushroom pests is added the species *T. waitei,* however.

The common usage of the term epimera, applying to conspicuous characters of the ventral integument, is discouraged, with evidence offered in support of the term apodemes as correct reference to such structures. Attention is directed to a hitherto unreported structure in this group of mites which is designated as the anal plate.

The bionomics of members of the Tarsonemidae is related in some detail. Sexually or parthenogenetically produced eggs hatch into six-legged, active larvae which eventually transform into a quiescent "pupal" stage from which eight-legged adults eventually emerge. Parthenogenetic reproduction results in male individuals only in the few species studied by this author. Other reliable records indicate that parthenogenesis in some species may result in females only or in both sexes. Tarsonemid mites in general appear to have a narrow or restricted range of ecological tolerances. Further work on tarsonemid ecology is encouraged as also is the need for detailed, comprehensive study of the taxonomy of Old World species.

INTRODUCTION

The first comprehensive work on the mites belonging to the family Tarsonemidae was published in 1939 by H. E. Ewing. Both prior to and since the appearance of Ewing's paper little has been added to the knowledge of the taxonomy of the group with the exception of the description of two new European species by Cooreman (1941, 1947). The number of papers published on mites in this family with other than a taxonomic approach have been prodigious, particularly those concerned with applied entomology or applied acarology.

The importance of tarsonemid mites to agriculture has long been established. The importance of this group in the fields of public health and medical acarology is a matter of record, yet to date no conclusive evidence has been presented to irrefutably incriminate tarsonemids as a direct cause of human suffering. This is not beyond the realm of possibility, however.

In order to better understand the mites of this family it is of primary importance to establish the relationships of the included species to each other and to establish names indicating these relationships. Because of existing difficulties in classifying tarsonemid mites little interest in the group has been shown by collectors, an interest which often is not encouraged by the extremely small size of the mites. For this reason few noneconomic species have been collected, and many of those which have been collected have been very poorly mounted or preserved.

The writer's interest in this group of mites was first aroused early in 1949 during investigations of pest problems of nurseries in the San Francisco Bay Region of California. Extensive damage to numerous greenhouse crops was found to be caused by the cyclamen mite, and it is from identification of this species that further studies in the family stemmed.

ACKNOWLEDGMENTS

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HISTORICAL ACCOUNT

The family Tarsonemidae was erected by Kramer in 1877 based upon the genus *Tarsonemus* Canestrini and Fanzago which then included two species. The genus *Chironemus* described in 1876 by Canestrini and Fanzago to include a tarsonemid species was discovered to be a name occupied in the Pisces; these authors made the correction of the homonym in a subsequent publication in the same year redesignating the genus *Tarsonemus*. As originally described the genus was monobasic including the single species *Chironemus minusculus,* generic characters being based upon the female only as the male was unknown. At the time of correction of the existing homonymy a second species *Tarsonemus floricolus,* was described, again from females only.

As pointed out by Ewing in 1939, the original generic description permits recognition of mites belonging to the family which subsequently was based upon this genus in spite of the minor discrepancy on the nature of the claws of legs I. Recent findings appear to indicate that mites belonging to the family Tarsonemidae are characterized by a single claw on legs I which is contrary to the original interpretation of the character by Canestrini and Fanzago as well as by Ewing in his 1939 studies.

Early descriptions of tarsonemid mites were made by European workers; following the two species previously mentioned Kramer described *Dendroptus kirchneri* (1876) and Targioni-Tozetta described *Tarsonemus oryzae* (1878). In the decade which followed, descriptions of five more European mites were added to the group. It was in 1904 that the first tarsonemids of the Western Hemisphere were described, that of *Tarsonemus pallidus* in 1899 by Banks being the first of this series. Before Ewing's 1939 revision of the Western Hemisphere species, seven species and one variety had been described from this part of the world, six species of which were recognized as valid in the publication mentioned.

With the fluctuating taxonomic arrangement of acariens through time, the family Tarsonemidae, like many other such groups, has run the gamut of adjustment to fit the various interpretations and evaluations of characters for separation of the higher categories. Kramer in 1877 related the Tarsonemidae to Sarcoptiform groups principally on the basis of absence of tracheal openings. This arrangement was followed by Trouessart in his review of the classification of mites which appeared in 1891, this author further identifying the group as showing affinites with the Cheyletidae. Reuter in 1909 transferred the Tarsonemidae from the position showing close relationship to the Sarcoptiform groups to one more closely allied to the Trombidiform groups. Ewing in 1909 and again in 1929 and 1939, following the lead of Berlese (1897), clearly indicated that the tarsonemid mites belonged in the suborder Heterostigmata, the claim based upon recognition of the position of the tracheal openings, together with the characters of body segmentation and presence of pseudostigmatic organs located between the bases of coxae I and II, this position interpreted as showing a close relationship to the Sarcoptiform groups. Oudemans in 1902 proposed several new names for higher categories of the Acarina, one being the Trachelostigmata which included the tarsonemids as an isolated group having no close relationship to other known mite groups; this position has largely been abandoned in recent years, however. Banks in 1915 placed the family Tarsonemidae in the superfamily Sarcoptoidea the latter being one of the eight great groups of the order, this superfamily containing the family Sarcoptidae and six other families, all characterized by the lack of caudolateral stigmatal openings and the common occurrence of strong coxal apodemes or epimera and genital suckers. In 1929 and again in 1943 Vitzthum placed the family Tarsonemidae in the suborder Trombidiformes where it, together with several other families comprising the cohort Tarsonemini, showed close relationship to the prostigmate trombidiform mites, a position completely removed from the Sarcoptiform groups. This thesis is advanced by the present author with full knowledge that until a great deal more is known about the morphology and distribution of mites defense of several proposed alignments of the higher categories is tenable. Reasons for preference of the associations indicated are discussed further in this paper under the general subject heading of "Systematic Relationships." As mentioned previously, the most recent comprehensive work on the tarsonemid mites, namely that of Ewing (1939), recognizes these acariens as belonging to the superfamily Tarsonemoidea which is equivalent to the suborder Heterostigmata of some authors mentioned.

SYSTEMATIC RELATIONSHIPS

Although profound differences of opinion are rather commonly encountered among acarologists with regard to the systematic arrangement of the Acarina, most of the workers concur in the belief that, until more is known about mites in general, evaluation and establishment of characters for separation of the higher categories must of necessity be quite arbitrary.

Following the lead of such well-known early explorers in the field of acarology as Dugès, Kramer and Canestrini, Vitzthum (1943) in the latest comprehensive treatise of the order Acarina separates the group into six suborders essentially on the basis of the arrangement of the tracheal system. This character appears to be a conservative one and hence worthy for high category differentiation; and with the exception of some confusion being encountered relative to the difficulty of observing the character distinctly, particularly by earlier workers who were hindered by poor preparations and optical equipment, it segregates the Acarina into well-defined groups.

Some of the early workers following the classification based upon the tracheal system, due to inaccurate observations, erroneously placed the tarsonemid mites in the suborder Sarcoptiformes, which was characterized as having no tracheal openings. This error was made by Kramer and subsequently by Banks, Berlese and Ewing. The correct interpretation of the character was made by Vitzthum as indicated by his placement of the group in the suborder Trombidiformes (Reuter, 1909) including those mites with one pair of tracheal openings in the anterior portion of the body.

Within the suborder Trombidiformes appears a large array of small, oval or flattened mites with a smooth, shining cuticle often showing traces of segmentation, further characterized by the presence of a pair of clavate sense organs or pseudostigmatic organs (with a few exceptions) situated dorsolaterally between coxae I and II in adult females; mouth parts of both sexes consist of stout palpi, except in highly specialized parasitic species, and styliform chelicerae. These characters appear to refute the claims made by some workers for close relationship to the Sarcoptiformes, which superficially they resemble in general appearance. The latter suborder not only lacks stigmatal openings, but the mouth parts consist of stout, paired palpi and stout, chelate chelicerae which are never enclosed in an oral tube. Some sarcoptiform mites possess on the posterior dorsal region of the propodosma a pair of pseudostigmatic spines of variable structure which have been homologized with the pseudostigmatic organs of the tarsonemoid groups, an obvious misinterpretation of the structures involved in the opinion of the present author. Many sarcoptiform mites further are characterized by the presence of genital suckers which are never present in the tarsonemoid groups. Both groups are characterized by indications of body segmentation beyond the frequent acarien condition of distinct segmentation between the propodosoma and hysterosoma.

Until more information is available concerning biologies of the species in the two groups, little can be offered in the way of comparison. Biologies of the Tarsonemidae are discussed in a section of this paper which follows, but aside from a few species in other tarsonemoid groups relatively little is known regarding this phase of comparison. Many sarcoptiform and tarsonemoid species are found in close association with one another but direct comparison or contrast of the biologies of these controversial groups cannot be made by this author at the present time.

Although Ewing (1939) felt that the family Tarsonemidae as defined by this writer was only of subfamily rank it is the author's opinion that Vitzthum (1943) correctly recognized the group as one of sufficient distinctness to be re-elevated to family rank. In Ewing's classification the superfamily Tarsonemoidea (Heterostigmata of some authors) contained three families, namely, Disparipedidae, Pediculoididae and Tarsonemidae. The last family was further subdivided into three subfamilies namely, Tarsopolipinae, Podapolipinae and Tarsoneminae. The subfamily Tarsoneminae was restricted to include three genera, *Pseudotarsonemoides* Vitzthum, *Hemitarsonemus* Ewing and *Tarsonemus* Canestrini and Fanzago. Vitzthum (1943) recognized four families in the cohort Tarsonemini, namely, Scutacaridae, Pyemotidae, Tarsonemidae and Podapolipodidae. In the family Tarsonemidae the latter author placed the genera *Tarsonemus* C. & F., *Tarsonemoides* Trågardh, *Acarapis* Hirst, *Avrosia* Oudemans and *Microdispodides* Vitzthum. This writer, as indicated above, agrees with Vitzthum in his recognition of the heirarchial status of the family as well as in the distinction of the other three families; however, this writer would make the following changes in the classification as presented by Vitzthum: some genera recognized by Vitzthum in the Tarsonemidae should be relegated to other families; Ewing's subfamily Tarsopolipinae should be elevated to family rank, the Tarsopolipodidae; Trågardh's genus *Tarsonemoides,* Vitzthum's *Microdispodides* and *Pseudotarsonemoides* all appear to belong to the family Scutacaridae; of the other genera included by Vitzthum in the Tarsonemidae, Hirst's *Acarapis* and *Tarsonemella* both should be placed in the Tarsopolipodidae and Oudeman's genus *Avrosia* relegated to some other family, probably one in the sarcoptiform group. This grouping would restrict the family Tarsonemidae as characterized in the section on taxonomy which appears later in this paper and would include two of the genera included in the group by Ewing and Vitzthum, namely *Tarsonemus* (which was included by both authors), and *Hemitarsonemus* (included by Ewing).

Relationships of these families to one another is obscure since so little is known concerning morphology, distribution and bionomics of the included species. Such relationships are at best a matter of almost complete conjecture. In general morphological characters and to some degree in bionomics the species included in the family Tarsonemidae very closely resemble the members of the family Scutarcaridae. In the family Scutacaridae the cephalothoracic shield is prolonged concealing the capitulum, a condition approached in the genus *Hemitarsonemus;* body segmentation is conspicuous as in most of the Tarsonemidae; the fourth pair of legs in the females of some species have reduced segmentation and terminal setae as in the Tarsonemidae. Some of the highly specialized parasitic species of the Scutacaridae lack pseudostigmatic organs and possess two pairs of anterior stigmatal openings which differ considerably from the Tarsonemidae. In both families sexual dimorphism is marked.

The family Pyemotidae (=Pediculoididae) probably is less closely related to the Tarsonemidae as evidenced by the ovoviviparous method of reproduction and the morphological similarity of female legs IV to the other legs.

It is possible that the Tarsopolipodidae should be included in the Scutacaridae. Vitzthum (1943) included the genus *Acarophenax* in the family Pyemotidae, but Hughes (1948) declares that this genus appears to her to have a greater affinity to the Scutarcaridae. The present author will withhold conjecturing on the generic inclusions of these related families due to the fact that a sufficient number of specimens has not been studied.

EXTERNAL MORPHOLOGY AND TERMINOLOGY

(Plates 1 and 2)

Tarsonemid mites are very small, ranging in length from one tenth to one third of a millimeter. The integument is relatively hard in the mature forms and has a shiny surface. The body is rather sparsely beset with setae as are the hind appendages. The anterior pairs of legs, especially their terminal segments, are more densely clothed with setae and often are equipped with specialized sensory setae of various configurations and sizes.

Pronounced sexual dimorphism is characteristic. The males are not only much smaller in size than females of the same species, but the general body contour is markedly different. In the female the usual condition is an ovoid body shape with the anterior pairs of legs separated from the posterior pairs by a distinct interval and the dorsum of the body convex. A group of species in the genus *Steneotarsonemus* has apparently undergone much modification in respect to general body contour, no doubt related to the adaptation for their particular habitats. Females of these species are quite elongate, with the anterior and posterior pairs of legs widely separated. In addition, the mites of both sexes are dorsoventrally depressed which is indeed a configuration quite suitable for their activities in the confined spaces between the sheaths and stems of the grasslike hosts. In the genus *Hemitarsonemus* extreme convexity of the female dorsum is characteristic, the carapacelike dorsal idiosoma concealing from above the capitulum (in living specimens). This condition is approached in some of the species of *Tarsonemus.*

The body of a tarsonemid mite is divided into three well-defined portions and may be further divided by the use of established terminology as defined below. The mouthparts are contained in a distinct capsular head called the capitulum. The remainder of the body comprises the idiosoma which is transected by a definite and distinct suture, called the main body suture, between the anterior and posterior pairs of legs. The unsegmented area anterior to the main body suture is called the propodosoma and the portion of the idiosoma behind the main body suture is the hysterosoma. The propodosoma is a single, more or less continuous body region, which in some species has the dorsum prolonged anteriorly forming what is called a cephalothoracic or rostral shield which is sometimes separated from the remainder of the dorsal propodosoma by a suture. Such a prolongation or forward extension of the dorsum of the propodosoma, which occurs in many families of mites, has also been designated by various authors as the cephalothoracic hood or rostral hood. The hysterosoma may be further divided into anterior and posterior portions or that portion from the main body suture to the hind margins of coxae IV and the portion behind the legs. Names applied to these two regions of the hysterosoma are the metapodosoma and the opisthosoma, for the anterior and posterior portions respectively.

The mouth parts consist of stout, paired palpi of indistinct segmentation inserted on the apical portion of the capitulum, and slender, styliform, paired chelicerae the bases of which are inserted just medial to the bases of the palpi. In the genus *Rhynchotarsonemus* the palpi are extremely elongate, projecting forward to such an extent as to appear in the form of a snout. Situated medially and internally in the capitulum are paired, tubelike structures which are referred to in this paper as cheliceral sheaths. This terminology has been adapted because of the apparent function of the structures in enclosing the chelicerae when the latter are retracted. There remains the possibility that these structures serve an entirely different function, however.

Tarsonemids are characterized by the pronounced development of apodemes on the ventral portion of the body. Certain authors refer to these characters as epimera, but it is felt by the present writer that such reference is in error. There appears to be insufficient association with the coxal segments to be correctly called epimera, and if the structures were epimera the presence of an extended median structure would not be expected. Further studies on the morphology and internal anatomy will no doubt clarify this interpretation. The apodemes have been designated by the present writer as follows: apodemes I, which have their anterolateral termina in the region of the anterior margins of coxae I; apodemes II, which have their anterolateral termina in the region of the anterior margins of coxae II; anterior median apodeme, which is medial in position on the propodosoma; transverse apodeme, which is associated with the main body suture; apodemes III, which terminate posterolaterally in the region of the anterior extremities of coxae III; apodemes IV, which terminate posteriorly near coxae IV; posterior median apodeme which occupies a median longitudinal position on the metapodosoma.

The males are equipped caudally with a rather unique structure which Ewing and other authors refer to as the genital papilla. Actually the structure is more accurately described as a genital plate. However, this author has followed the established terminology in this instance. The papilla is situated terminally on the opisthosoma in living specimens (see Plate 2) but in microslide preparations it usually tilts to appear in a dorsal position with the dorsal margin thus appearing as the anterior margin and the ventral margin projecting caudad beyond the apex of the opisthosoma. It contains within its clearly defined limits the paired, styliform aedeagi as well as other accessory genital organs and appendages, the exact identity of which are as yet unknown. Another structure, referred to in this paper as the anal plate is often quite conspicuous in slide-mounted specimens. Its position in living males is subterminal on the ventral opisthosoma just anterior to the ventral margin of the genital papilla, although in microslide mounts this normal position is not often apparent. The plate is lacking in clearly defined lateral limitations, the most conspicuous portion of the structure being a central disc or aperature from which fingerlike apodemes radiate. The usual number of anal apodemes is three, two of which extend anterolaterally for a short distance from the anterolateral margins of the disc and the third projecting caudally from the posteromesal margin of the disc. However, in some species there may be four anal apodemes, two projecting from the anterior margin of the disc and two from the posterior margin, and one species has one apodeme projecting forward from the disc and two projecting caudad.

Females are characterized by the possession of specialized organs located dorsolaterally between coxae I and II. These organs, which vary somewhat in size and shape (see Plate 2), are of uncertain function and have been called clavate sense organs or pseudostigmatic organs by various workers. The term pseudostigmatic organs is used by the present writer although the applicability of this name is questionable. Probably these paired structures are highly modified sensilla trichodea and are more properly referred to as specialized sense organs, since they seem to have no relationship to the tracheal system.

There appears to be little or no evidence of a tracheal system in the males of tarsonemid mites. However, as methods of preparing specimens are refined and improvements are made on optical instruments, new light may be shed on this interpretation. In the females of the group the stigmatal or tracheal openings are quite distinct, being situated dorsolaterally near the anterior margin of the propodosoma. From these external orifices extend the tracheae which converge medially in the region of legs II, diverging posteriorly from this point, disappearing inconspicuously in the opisthosomal region. In some species the tracheae connect with paired, heavily sclerotized, elongated structures situated medially near the point of convergence of the tracheae or in subspheroidal, dilated pouches similarly situated. These structures are probably atria (see Plate 2). It is obvious at this point that there is much need for further studies on the internal anatomy of the mites in this family.

Classification of the family Tarsonemidae has been based largely upon characters of the hind pair of legs of the males, this being a logical method of separation because of the variability of these appendages. Legs IV of the males may be regarded as accessory copulatory appendages because of their function in premating behavior and the mating process. It appears that these appendages are highly modified in various ways presumably representing adaptations developed for better performance of these functions. A plastic character such as this lends itself well in distinguishing the lower categories. In general, legs IV of the male are four-segmented, but in some species a fusion of the tibia and tarsus has reduced the segmentation. We may assume that this represents, in this single character, specialization by reduction. Likewise, the terminal claw of these appendages varies considerably from the condition of prominence to that of nearly complete degeneration.

Modifications of the femur are quite evident in some species groups, ranging from a thin, membranelike, inner flange to a spurlike projection of the inner margin. This type of specialization is probably related to the requirements of the various species in the copulatory process, for this pair of legs functions only passively in locomotion. The individual setae of this pair of appendages have been named by Ewing which facilitates reference to them, but since setae of other appendages are not so named this writer has not followed Ewing's nomenclature for the chaetotaxy of the male leg IV.

In descriptions of species which follow in this paper most of the body setae are identified by size, shape, and location. There are several types of specialized setae ranging from the normal condition, which is that of a rather narrow base from which the seta tapers to a threadlike apex, to modified types which may appear clavate, lanceolate, peglike, or of various other shapes. Leg segments are referred to by name except in cases where names cannot be applied with any degree of certainty due to a lack of knowledge of the homologies involved. Many acarologists prefer to follow the numerical system of identifying leg segments; but under this system, in instances of reduced number of segments, the place of reduction is not identified and the resulting lack of homology confuses the picture.

Chaetotaxy of the legs is described on the basis of normal orientation of the mite on a microslide. This position is with legs I and II extending forward and the posterior pairs extending to the rear. By reference to this "normal" position the geographic location of the seta is readily and easily indicated by the simple statement of dorsal or ventral position with further indication stated in terms of the outer or inner margin of the segment, that is the margin away from or close to a hypothetical line bisecting the mite along the longitudinal axis, respectively.

There is considerable need for standardization of terminology in the entire field of acarology, and it appears that this need will be satisfied only after further studies have been made on the various groups, so that homologies of structures as well as proper identity or interpretation can be made.

GEOGRAPHICAL DISTRIBUTION

Because of the paucity of specimens of the family Tarsonemidae in collections, little can be said about the geographic distribution of the group. From information which may be gleaned from studies of available material and from published reports, it seems that the family is predominantly a tropical or subtropical one.

Tarsonemids have been reported from all of the major zoogeographical regions of the world and range over a diversity of climatic conditions. One species has been reliably reported from Europe, Asia and North America, another is found commonly in Europe and North America and probably occurs elsewhere. Still another species has been taken in Australia, Hawaii and North America. However, large collections of mites taken in the Arctic have contained no tarsonemids. Until more areas are collected for these mites it will remain impossible to correlate distributional data with the possible place of origin of the group or to integrate distribution into a solution of the problem of relationships within the family.

BIONOMICS

With the exception of two species, comprehensive biological studies have not been conducted on tarsonemid mites. Garman (1917), Moznette (1917), Massee (1933) and Smith and Goldsmith (1936) published information obtained from biological studies of *Steneotarsonemus pallidus* (= *Tarsonemus pallidus*). Cameron (1925) successfully reared and reported the results of biological studies of *Hemitarsonemus latus*. The present writer conducted some rather limited investigations into the bionomics of a few species, the resuts of which are recorded in the discussion which follows.

All tarsonemid mites thus far studied have four distinct stages in their life history. Eggs are laid singly by the gravid female. They are white, ovoid, opaque, and large in comparison to the size of the adult. In some species the smooth surface is dotted with small, tubercular swellings and others have the surface broken by numerous pitlike depressions. The egg hatches into the six-legged larva which is white, opaque with the two anterior pairs of legs situated as in the adult, the posterior pair in the position of legs III of the adult. Larvae are further characterized by the presence of a peculiar enlargement of the opisthosoma into a triangular platelike development which is most prominent in males. Larvae of males are considerably smaller than female larvae. From this active stage the mites of both sexes enter a quiescent "pupal" stage in which transformation to the adult takes place. This stage is sessile and the larval integument appears inflated or bloated with the cuticle tightly stretched. Transformation to the adult takes place within the larval skin through the successive stages of withdrawing the appendages from the old integument and formation of legs IV behind legs III as well as development of genitalic structures. The pupal skin splits dorsally at the completion of the transformation to the adult and the mature individual emerges. Usually the integument darkens somewhat following emergence. Sexual dimorphism is pronounced in all members of the family Tarsonemidae. Males, in general, are about two thirds as large as females.

The color of many species seems to vary according to the food ingested. Some of the phytophagous species are commonly green; fungivorous species may assume a body color comparable to the color of the fungus upon which they have been feeding. Thus it appears that body color generally is not a reliable diagnostic character.

Locomotion by females is accomplished by the use of all four pairs of legs. The mites walk on the ventral subterminal setae of legs IV. In the males the hind legs are rarely used in locomotion, most frequently being carried in a semierect position above and behind the body. These appendages are invariably used by the males in transporting "pupae" and adult females both of which are carried on the male's back near the cauda in the grip of legs IV and fastened to the male by structures or appendages of the genital papilla. Larvae have never been observed by this writer nor reported by other investigators as being carried by males. Female "pupae" which are nearly mature are more frequently the portage than are adult females. Males have been observed by this writer carrying male "pupae," although this appears to be unusual. The present writer also observed males of *Tarsonemus setifer* carrying "pupae" of *T. pritchardi.*

Parthenogenesis is common, but there appears to be some difference of opinion concerning the type of progeny resulting from this type of reproduction. Garman (1917) offers conclusive evidence that offspring of *Steneotarsonemus pallidus* resulting from parthenogenetic reproduction are invariaby females, having successfully reared this species through several generations without the appearance of males. Gadd (1946) in rearing *Hemitarsonemus latus* found that unfertilized eggs of this species produced only males. The present writer in rearing *Tarsonemus randsi* and *T. setifer* found the results of parthenogenesis to be the same as that reported by Gadd.

Optimum environmental conditions for the various species studied appear to involve a combination of warm temperatures, high humidity and low light intensity. Tarsonemid mites are known to survive in the adult stage through prolonged exposure to freezing temperatures but seem sensitive to temperatures above 35° C. Garman (1917) reports that a relative humidity of from eighty to ninety percent is optimum for S. *pallidus.*

There is some indication of the existence of a correlation between hosts and the taxonomic units established in this paper. In the genus *Steneotarsonemus,* four of the ten descibed species feed upon grasses or grasslike plants. Of the remaining six species three feed on other monocotyledonous plants. S. *ananas* is restricted in its host selection to pineapple which is a member of the plant family Bromeliaceae and which, although it is a monocotyledonous plant, bears no close relationship to the Graminiae. The scant evidence available suggests banana as a possible host of S. *latipes,* this plant also being a monocotyledon in the family Musaceae. S. *laticeps* apparently feeds only on plants in the family Amaryllidaceae. Two of the remaining species in the genus, namely, S. *pallidus,* and S. *fulgens,* apparently feed on dicotyledonous plant species. S. *chionaspivorus* is recorded as predatory, but the present writer feels that it is a fungivorous species. The unusual biological characteristic of S. *ananas,* together with certain morphological inconsistencies set this species apart somewhat from other members of the genus.

The two members of the genus *Hemitarsonemus* about which host relationships are known are phytophagous, one being relatively host specific to ferns, the other a general plant feeder. The third species has yet to be studied in this regard, its food habits being unknown at the present time.

The single species in the genus *Xenotarsonemus* is probably phytophagous, although conclusive evidence has yet to be presented in this regard. Likewise, the host relationships of the single species in *Rhynchotarsonemus* are not clearly understood, although this writer reared several generations on cultures of combinations of algae and fungus. The entire complement of the genus *Tarsonemus* is probably fungivorous.

Natural enemies of tarsonemid mites have occasionally been reported by other workers. Bianchi (1940) reported *Podothrips lucasseni* as predaceous on S. *ananas* in Hawaii. Natural enemies observed by this writer include members of two predaceous mite families, namely, the Cheyletidae and the Phytoseiidae. Smith and Goldsmith (1936) report the predatory phytoseiid, *Seiulus sp.,* as responsible for considerable depredation in populations of the cyclamen mite. McGregor (1944) reports *Cheyletogenes ornatus* as a predator of *Tarsonemus setifer* in southern California. Because of the very small size of tarsonemid mites and their sequestered habits, they usually escape the ravages of predators.

ECONOMIC IMPORTANCE AND CONTROL

The first definite record of tarsonemid damage to an agricultural crop seems to have been that made by Bancroft in 1877 in which *Steneotarsonemus bancrofti* was noted as a pest of sugarcane in Queensland. In 1878 Targioni-Tozetta reported *Tarsonemus oryzae* as a pest of rice in Italy. Since these early records numerous other species of tarsonemid mites have been incriminated as agricultural pests, some were recognized as parasites of scale insects, others were suspected as having a parasitic relationship to higher animals including man and some were indicated as fungus feeders. Most of these records of host relationship, in the opinion of this writer, should be investigated further.

The species of undisputed agricultural significance include *Tarsonemus randsi, Steneotarsonemus spirifex, S. bancrofti, S. laticeps, S. phyllophorus, S. ananas, S. pallidus, Hemitarsonemus latus* and *H. tepidariorum.* Mackenzie (1922) and Hirst (1922) reported the finding of *T. floricolus* in human urine and the former author presents rather convincing evidence that this species did not occur as an accidental contaminant; three case histories are cited in support of a conclusion that *T. floricolus* is a direct cause of human suffering due to the effects of mites invading the urinary system of man.

Tarsonemus affinis was reported by Harada (1925) as a possible parasite of man, being found in human urine, however, the possibility of external contamination of the urine sample was never completely eliminated. In spite of the Mackenzie report, the present author finds the incrimination of tarsonemid mites as internal parasites of man untenable. The morphology of these mites is such that burrowing through membranes is improbable if not impossible and it is likewise inconceivable that the invaders could gain access to a human bladder in any other manner except, perhaps, under extremely extraordinary circumstances such as perverse behavior by the invaded person. Dahl (1910) mentioned a possible relationship between *Tarsonemus sauli* and horses. Oudemans (1903) suggested a possible host-parasite relationship between *T. soricicola* and shrews.

Of the economic species mentioned above it is generally considered that *Steneotarsonemus pallidus* causes the greatest amount of damage followed closely by *Hemitarsonemus latus.* Both of these species have enormous host ranges which include many commercially grown crop plants, and as a consequence these species have been studied rather intensively both from the biological and control standpoints. *Tarsonemus randsi* is a pest of considerable importance in the commercial growing of mushrooms, and also may be quite destructive in its invasions of fungus cultures in research laboratories. Other species in the genus *Tarsonemus* have also been found in laboratory fungus cultures and control of such invaders without damaging the fungi or culture media has been the subject of several published reports (Carpenter, 1914; Jewson and Tattersfield, 1922; Shafik and Page, 1930; Puntoni, 1931; Barnes, 1933; Page and Shafik, 1936; Hansen and Snyder, 1939; Crowell, 1941; Snyder and Hansen, 1946.).

Control of tarsonemid mites has long defied all efforts of numerous workers to obtain a satisfactory solution. Chemical controls directed against infestations have included nicotine solutions, lime-sulfur, sodium selenate, oil emulsions, sulfur dusts, naphthalene and calcium cyanide fumigation and others, all with varying reports of success and failure. Other methods of control recommended included hot water immersion and heat treatment (Smith and Goldsmith, 1936). More recent recommendations for tarsonemid mite control include methyl bromide fumigation (Breakey, 1943; van Marle, 1944), although Richardson et al (1943) mention resistance of S. *pallidus* to this fumigant, "lorol" thiocyanate sprays (Goodhue and Smith, 1944), di(p-chlorophenyl) methyl carbinol (Pritchard and Beer, 1949a), parathion (Pritchard and Beer, 1949b) aramite or 2-(p-tert-butylphenoxy) isopropyl 2-chloroethyl sulfite, toxaphene and malathon or S-(1,2-dicarbethoxyethyl) 0,0-dimethyl dithiophosphate (Pritchard, 1951). Further screening tests on chemical control of the cyclamen mite (Pritchard, 1951a) indicate that toxaphene sprays provide effective control with a minimum of plant injury. Sprays using from one to two quarts of sixty percent emulsion concentrate per one hundred gallons of water applied under greenhouse conditions with a repeat application seven days following the first spraying resulted in one hundred percent control of the mites on heavily infested ivy plants in tests conducted by the present author. At the heavier dosage, with one percent oil included, the foliage of stephanotis and gardenia plants was injured somewhat in plant tolerance tests. At the lighter dosage foliage of cyclamen and blooms of saintpaulia showed spray damage.

To summarize the control of tarsonemid mites, the following are effective methods of eliminating or minimizing infestations: hot water treatment of sugarcane cuttings and new planting stock of strawberries to prevent introduction of *Steneotarsonemus bancrofti* and S. *pallidus* respectively; spraying with di(p-chlorophenyl) methyl carbinol, malathon, parathion or toxaphene within the limits of plant tolerance and at concentrations known to be lethal to the mites; methyl bromide fumigation of nonsensitive, infested plants. Repeat applications of acaricidal sprays are often necessary in order to obtain coverage of leaf surfaces inaccessible at the time of the first application.

Artificial controls have never been directed against such species as *Tarsonemus oryzae* infestations on oats and rice nor against *Steneotarsonemus spirifex* on corn, oats and other grains, probably due to the fact that the economics involved in margin of profit of such crops precludes application of extensive and perhaps questionable controls. Infestations of *Tarsonemus randsi* in fungus cultures in research laboratories of plant pathology were treated, under this author's observations, with pyridine, in concentrations recommended by Jewson and Tattersfield (1922) for the control of other mite species causing damage to such cultures, with no success. A period of seventy-two hours exposure of the agar slant cultures to an atmosphere of pyridine in a hermetically sealed container proved lethal to the fungus and resulted in less than a fifty percent mortality in the mite population. Tarsonemid mites are extremely resistant to even the most severe treatment with the usual acaricides. Most species will survive a two hour submergence in water. On the other hand they appear to succumb readily to mild heat or desiccation.

COLLECTION AND PREPARATION

Tarsonemid mites, because of their extremely small size, are most easily collected by examining various suspected materials in the laboratory under a dissecting microscope. Such items as tree bark, twigs, fruit, roots, stolons, leaves, flowers and the like may harbor tarsonemids, which to most observers will be invisible to the naked eye. These may be picked off the substrate on a single-haired brush or with a micro-needle and transferred to alcohol. Ninety-five percent alcohol is used in collecting bottles because of the advantage offered by its low surface tension; mites quickly fall from the brush or needle into this preservative. At times these mites may be successfully collected in quantity by enclosing plant material in a wide-mouthed container over the top of which a piece of porous paper has been secured tightly. As the plant material desiccates the mites wander to the top of the container. This porous paper top may be removed from time to time and examined for mites under a low power microscope. Tarsonemid mites may also be collected by the Berlese funnel technique. This writer prefers to collect tarsonemid mites wherever possible by some method employing individual picking rather than a mass washing type of process. The reason for this is that dirt and other foreign objects are difficult to remove from a tarsonemid and because of the small size of the mites even a very tiny artifact may completely ruin the prepared specimen.

The most satisfactory mounting medium, in this writer's opinion, is polyvinyl alcohol with lactic acid and phenol added according to the formula given below. Various recipes for Berlese media have been tried but most of these crystallize in a relatively short time. The formula for the Berlese mounting medium found most satisfactory by the author is also given below. Because of the probable nonpermanent nature of these media some preparations have been made in various of the recognized permanent media, such as hyrax and balsam.

In preparing a PVA-L-P mount the mite is removed from alcohol and heated gently in lacto-phenol clearing solution, the recipe for which is given below, until cleared. Transfer is made directly from the clearing solution to a slide containing a drop of PVA-L-P. The mite is submerged in the mounting medium and the cover slip put in place. Gentle heat such as that imparted by placing the slide for two or three minutes on the metal shade of a gooseneck lamp is then applied. Care must be taken to avoid using too much mounting medium or the legs and capitulum may come to rest in a semi-vertical plane in which case characters are obscured. An insufficient quantity of medium on the slide may result in too much crushing of the specimen or withdrawing of the medium from the edges of the cover slip as the PVA-L-P dries. Mites may be placed alive or directly from alcohol into PVA-L-P, the cover slip put in place, mild heat applied for a short time and excellent preparations result, due to the clearing action of the lactic acid and phenol in the medium. Preliminary clearing as a general rule results in better mounts, however. (See Lipovsky, 1953.)

For Berlese mounts, specimens are removed from alcohol, placed directly in a drop of Berlese medium on the slide, the cover slip then put in place and mild heat applied, with excellent preparations resulting. Such slides should be watched carefully for signs of crystallization, which usually become evident first near the edges of the cover slip. If this occurs the specimens should be remounted. Remounting from Berlese is a simple process, the cover slip being removed easily after soaking the slide for a time in warm water.

Balsam mounts have been prepared by this writer by removing specimens from ninety-five percent alcohol and soaking them for twenty-four hours in methyl cellosolve. From this solvent they are moved directly to balsam and the cover slip applied. Without the intervention of methyl cellosolve the body and especially the legs often collapse. Successive steps through the higher alcohols to xylol or clove oil also frequently resulted in collapsed or partially collapsed specimens.

Hyrax mounts involve considerable time in preparation, but excellent preparations may be just reward for the effort involved. The technique described by Newell (1947) with certain modifications is the one followed by this writer. Specimens are cleared thoroughly in lacto-phenol solution followed by further clearing in KOH. After washing in water the cleared specimens are run through the alcohols to absolute alcohol. The mites are then floated in alcohol on top of a tube of alpha-chloronaphthalene. In an oven adjusted to about fifty degrees centigrade the absolute alcohol evaporates and the specimens infiltrate into the alpha-chloronaphthalene. After a few days in "acn" the mites are transferred to a drop of hyrax mounting medium on a slide, submerged and the cover slip applied. From the beginning of the clearing process to the stage of transferral of the specimen to the hyrax, specimens are handled only in a pipette. The final transfer to the slide is made by picking the specimen out of the acn on a micro needle and placing it in the hyrax. Specimens mounted in hyrax, which has a rather high refractive index, show some advantages over specimens mounted in some of the other "permanent" media such as balsam which have a lower index of refraction.

This writer, as a matter of policy, rings all slides with Zutt's ringing compound. The reason for this is twofold: oxidation, excessive dehydration and crystallization of the various media are delayed; also, slides are more easily maintained in a clean and neat condition if ringed, particularly following examination under oil. For further information on mounting techniques, particularly the placing of labels and the like, the reader is referred to Hood's (1947) manual.

MOUNTING MATERIALS

Hyrax (Newell, 1947), modified by present writer

Clear with digesting solution: (0.2 gm. trypsin powder in 10 cc. 0.5% Na_2CO_3, filtered after standing for several hours in toluene atmosphere.)

Wash specimen with water, then dehydrate with alcohols.

Specimen in absolute alcohol poured into tube containing alpha-chloronaphthalene; oven at 40° C.

From acn to hyrax dissolved in acn (mountant) after infiltration of specimen by acn is complete (alcohol completely evaporated).

PVA-L-P (Downs, 1943)

Water	50 cc.
DuPont "Elvanol" Add to water slowly until thick paste forms and powder no longer moistens quickly.	
Lactic acid	22 cc.
Phenol crystals	22 cc.
Add to lactic acid and dissolve before adding this mixture to "Elvanol" paste.	

("Elvanol"—Low viscosity—Type B—Grades 70-05 and 90-25 have been used successfully by the present writer.)

PVA-L-P (Jones modification)

PVA (In 250 cc. flask)	6.3 gms.
Absolute alcohol saturated with picric acid Add to flask and stir to paste.	18 cc.
Lacto-phenol Add to flask and heat mixture in water bath until clear. (This mixture permits staining in mounting medium.)	45 cc.

Hoyer's Solution (A modified Berlese mounting medium)

Water	50 cc.
Gum Arabic (clear crystals)	30 gms.
Chloral hydrate	200 gms.
Glycerine	20 cc.

(Mix at room temperature in above sequence; mount directly from life, water or alcohol.)

C-M Medium (Clark and Morishita, 1950)

Methocellulose ("Methocel": Vernol Chemical Co.)	5 gms.
Carbowax 4,000 (Carbide and Chemical Corp.)	2 gms.
Diethylene glycol	1 cc.
Ethyl alcohol, 95%	25 cc.
Lactic acid	100 cc.
Distilled water	75 cc.

(Mix 1 and 4; add to others; filter through glass wool. Oven 40-45° C 4-5 days. Thin if necessary with 4. Mount directly from alcohol, lactic acid or cellusolve.)

Lacto-Phenol Clearing Solution

Lactic acid	50 cc.
Phenol crystals	25 cc.
(Add to lactic acid to bring total volume to 75 cc.)	
Distilled water	25 cc.

TAXONOMY

Until mites belonging to the family Tarsonemidae have been collected in sufficient numbers from as many different geographical locations and ecological situations as possible, the author feels that evaluation of characters in phylogenetic studies or even in group definition is impossible. It is felt that complete and accurate descriptions of all known species, even though such descriptions may be exceedingly prolix, is the only solution for determining the conservativeness or plasticity of morphological characters. Most descriptions of new species of tarsonemid mites have been entirely inadequate for the purposes of comparison with known species. To add to the confusion in the group, European workers have cared little for and regarded less the work of American acarologists with the family Tarsonemidae and vice versa. From time to time in the past attempts have been made to integrate the European and American studies, not only with this family but also with other acarien groups. Reconciliation was finally made between the two names, *Tarsonemus pallidus* Banks and *T. fragariae* Zimmerman, as well as between a few other species. However, until the family Tarsonemidae is much better known it seems advisable to describe species in minute detail in order to facilitate comparison of species by workers in other parts of the world.

Much type material has not been available to the author for study to date, and as a result the validity and often the proper taxonomic position of certain species cannot be decided with certainty. In such instances the best reference available for the species is cited and the species in question is discussed in a position in this paper showing its proper relationship, with opinions of the present author freely expressed in this regard.

Thus, this paper is an attempt to solidify the status of a few of the described species of tarsonemid mites and to leave the remaining species with their position in the taxonomic picture subject to change after further studies have been made.

Throughout the family Tarsonemidae there exists a great morphological similarity among females which complicates the problem of segregation at the generic level when this sex alone is considered. However, it is obvious that the present writer is convinced that the family is divisible into distinct generic units on the basis of male characters. Owing to the fact that females present this somewhat confusing problem, a key to assist in identifying Western Hemisphere species is appended to the present paper in which the entire complement of the family in this region is considered without regard to generic segregation (see Addendum, p. 1321).

On the basis of some rather intangible morphological characters discernible in the group, the genus *Tarsonemus* appears to be divisible into two groups. One of these groups, referred to in this paper as the Setifer Group, includes nine species, namely, *T. setifer*, *T. occidentalis*, *T. smithi*, *T. randsi*, *T. cryptocephalus*, *T. laminifer*, *T. sulcatus*, and possibly *T. dispar* and *T. truncatus*. The other group, referred to as the Confusus Group, appears to include the remaining species in the genus. The distinction between these groups at the present writing is not sufficiently concise to permit consideration of subgeneric separation but it is conceivable that such a classification may develop as studies progress.

DESCRIPTION OF THE FAMILY TARSONEMIDAE

Small mites with shining integument; capitulum capsular bearing apically paired, simple palpi, the chelicerae styliform; idiosoma distinctly divided into propodosoma and hysterosoma, further segmentation of hysterosoma indicated particularly in female; one pair of pseudostigmatic organs located dorsolaterally between legs I and II of female, this sex with one pair of tracheal openings located anterodorsally on propodosoma, male without either pseudostigmatic organs or tracheal openings; both sexes with single claw on front legs, two claws on legs II and III; leg IV of female four-segmented, terminal segment with two long setae and without claws; legs IV of male often highly modified as accessory sexual appendages, with three or four segments, with or without terminal claw; male with a large genital papilla situated at apex of hysterosoma.

Type genus: Tarsonemus Canestrini and Fanzago (by original designation of Kramer, 1877).

KEY TO THE GENERA OF THE FAMILY TARSONEMIDAE

1. Palpi of both sexes prolonged anteriorly forming an elongate beak . . . . *Rhynchotarsonemus,* p. 1221
   Palpi of both sexes projecting slightly beyond apex of capitulum but never forming an elongate beak 2
2. Males without claws, empodia or knoblike arolia on tips of legs IV . . . . *Xenotarsonemus,* p. 1314
   Males with legs IV terminating in a claw or a knoblike pretarsal element 3
3. Males with body laterally compressed; tibia and tarsus or tibiotarsus IV slender, elongate, more than three times as long as basal width of tibia or tibiotarsus . . . . *Hemitarsonemus,* p. 1291
   Males with body dorsoventrally depressed; tibia and tarsus or tibiotarsus IV at most two and and one-half times as long as basal width of tibia or tibiotarsus 4
4. Males with large, flangelike expansion on inner margin of femur IV or if absent then fourth dorsal propodosomal seta in linear arrangement with setae of three preceding pairs or capitulum broader than long . . . . *Steneotarsonemus,* p. 1230
   Males with inner flange on femur IV absent or greatly reduced in size; fourth dorsal propodosomal seta always laterad from third seta or capitulum longer than broad . . . . *Tarsonemus,* p. 1114

Genus *Tarsonemus* Canestrini and Fanzago

Tarsonemus Canestrini and Fanzago, 1876, Atti Soc. Veneto-Trentina Sci. Nat., Padova, vol. 5, p. 142; Kramer, 1877, Arch. für Naturgesch., vol. 43, no. 1, p. 215; Canestrini and Berlese, 1884, Atti della Societa Veneto-Trentina, vol. 9; Canestrini, 1888, Prospeto dell' acarofauna Italiana Padova, vol. 3, p. 313; Berlese, 1894, Acari, Myriapoda et Scorpiones hucusque in Italia reperta, fasc. 75, no. 1-2; Sicher and Leonardi, 1894, Bull. Soc. Veneto-Trentina Sci. Nat., vol. 5, p. 183; Banks, 1899, Proc. Ent. Soc. Washington, vol. 4, p. 294; Banks, 1904, Jour. Roy. Agr. Soc. England, vol. 65, p. 273; Ewing, 1911, Psyche, vol. 18, no. 1, p. 37; Banks, 1912, Proc. Ent. Soc. Washington, vol. 14, p. 96; Quayle, 1912, California Agr. Exp. Sta. Bull., 234, p. 503; Quaintance, 1912, U. S. Dept. Agr., Bur. Ent. and Plant Quarantine, Bull. 97, pt. 6, p. 103; Rutherford, 1913, Trop. Agr. Peradeniya, vol. 41, no. 6, p. 490; Banks, 1914, Jour. Ent. and Zool., vol. 6, p. 55; Banks, 1915, U. S. Dept. Agr. Rept. 108, p. 104; Oudemans, 1915, Ent. Ber., vol. 4, p. 186; Oudemans, 1915, Arch. für Naturgesch., vol. 81, abt. A, heft 5, p. 76; Ewing, 1917, Jour. Econ. Ent., vol. 10, no. 5, p. 497; Harada, 1925, Japan Medical World Tokyo, vol. 5, no. 9, p. 251; Oudemans, 1926, Ent. Ber., vol. 7, p. 67; Oudemans, 1927, Tijdschr. voor Ent., Gravenhage, vol. 70, p. XXXV; Vitzthum, 1928, Zool. Anz., Leipzig, vol. 75, p. 281; Oudemans, 1929, Ent. Ber., vol. 7, no. 166, p. 421; Vitzthum, 1929, Tierwelt Mitteleuropas, bd. 5, lief 3, p. 40; Vitzthum, 1929, Ent. Tidskr., vol. 50, heft 2, p. 97; Ewing, 1929, Manual of external parasites, p. 36; Ewing, 1929, Proc. Ent. Soc. Washington, vol. 31, no. 2, p. 31; Puntoni, 1931, Ann. Parasit., Paris, vol. 9, no. 4, p. 359; Massee, 1933, Ann. Mag. Nat. Hist., London, vol. 11, p. 198; Oudemans, 1936, Tijdschr. voor Ent., vol. 81, p. V; Ewing, U. S. Dept. Agr. Tech. Bull., 653, p. 10; Cooreman, 1941, Bull. Mus. Hist. Nat., Belgium, vol. 17, no. 20, p. 1; McGregor, 1942, California Citrograph, vol. 27, no. 10, p. 270; Hughes, 1948, Mites associated with stored food products, London, p. 80.

Genotype: *Chironemus minusculus* Canestrini and Fanzago (by original designation).

Chironemus Canestrini and Fanzago (not Cuvier 1829, Pisces), 1876, Atti. Soc. Veneto-Trentina Sci. Nat., Padova, vol. 5, p. 110; Ewing, 1939, U. S. Dept. Agr. Tech. Bull., 653, p. 10.

Monotypic genotype: *Chironemus minusculus* C. and F.

Dendroptus Kramer, 1876, Arch. für Naturgesch., vol. 42, p. 28; Ewing, 1939, U. S. Dept. Agr. Tech. Bull., 653, p. 11.

Genotype: *Dendroptus kirchneri* Kramer (by original designation).

Cheylurus Trouessart, 1884, Bull. Soc. Etude Sci. d'Angers, vol. 14, p. 90; Canestrini, 1885, Prospeto dell' Acarofauna Italiana, Padova, vol. 3, p. 311; Berlese, 1894, Acari, Myriapoda et Scorpiones hucusque in Italia reperta, fasc. 75, no. 1; Ewing, 1939, U. S. Dept. Agr. Tech. Bull., 653, p. 11.

Genotype: *Cheylurus socialis* Trouessart (by original designation).

This genus is characterized by a subcordate capitulum with palpi never prolonged to form snoutlike beak. Males usually with inner margins of femora IV unmodified, not produced into a flangelike enlargement nor spurlike process; tibia and tarsus or tibiotarsus IV not conspicuously incurved; leg IV always with a terminal claw; four pairs of dorsal propodosomal setae, those of fourth pair never in linear arrangement with three anterior pairs. Females with lobelike tracheal expansions or atria usually absent or reduced in size, never bilobed; cephalothoracic shield, if developed, never projecting over more than basal half of capitulum; first pair of ventral propodosomal setae never in front of apodemes I.

Type of genus: *Chironemus minusculus* Canestrini and Fanzago (by original designation).

This genus appears to be the most primitive of the natural groups in the family. The lack of extreme specialization of the hind legs of the male, unspecialized mouth parts in both sexes and lack of specialized respiratory structures in the female are some of the characters which appear to indicate it is a group least removed basically from the ancestral type. From the scanty collection records it appears that the majority of species in this group suggest a rather general or cosmopolitan distribution. The fact that they show little host preference, all being fungus or alga feeders, tends to support this idea of their primitive nature.

The genus *Tarsonemus,* as presently defined, undoubtedly will be much larger than any of the other genera in the family. Further collecting of tarsonemid mites and the compiling of distributional data may bring to light additional useful information regarding the relationships of included species as well as the affinities of this genus with other groups in the family.

Key to the Males of the Genus Tarsonemus

1. Femur IV angulate at base 2
   Femur IV not angulate at base 5

2. Tactile seta of tibia IV much longer than femur IV, *cryptocephalus,* p. 1162
   Tactile seta of tibia IV as long as or shorter than femur IV 3

3. Dorsal seta of femur IV much longer than either of ventral setae; first and fourth dorsal propodosomal setae nearly of same size . . . . *occidentalis,* p. 1117
   Dorsal seta of femur IV with same length or shorter than longest ventral seta of segment; first dorsal propodosomal seta distinctly longer than fourth 4

4. Fourth dorsal propodosomal seta distinctly longer than second seta; coxa IV as long as broad; claw IV slender and long, *scaurus,* p. 1213
   Fourth dorsal propodosomal seta having length approximately equal to second seta; coxa IV broader than long; claw IV short and stout . . . . *confusus,* p. 1173

5. Tactile seta of tibia IV very long, longer than leg IV 6
   Tactile seta of tibia IV never as long as leg IV, usually shorter than femur IV 8

6. Third dorsal propodosomal setae longer than other dorsal propodosomals; femur IV more than twice as long as greatest breadth . . . . *setifer,* p. 1125
   Third dorsal propodosomal setae shorter than others or with nearly same length as first pair; femur IV less than one and one-half times as long as greatest breadth 7

7. Second dorsal propodosomal setae much shorter than other dorsal propodosomals; second dorsal hysterosomal setae as long as first dorsal hysterosomals . . . . *simplex,* p. 1188
   Second dorsal propodosomal setae with same length as setae of fourth pair, only slightly shorter than setae of first and third pairs; second dorsal hysterosomal setae shorter than first dorsal hysterosomals . . . . *pritchardi,* p. 1202

8. Femur IV with a small but clearly defined flange projecting from its inner margin 9
   Femur IV without inner flange 11

9. Flange occupying entire inner margin or distal portion of femur IV; dorsal seta of femur IV shorter than one or both ventral setae of segment 10
   Flange occupying proximal portion of femur only; dorsal seta of femur IV longer than ventral setae of segment . . . . *sulcatus,* p. 1155

10. Second and fourth dorsal propodosomal setae much shorter than other dorsal propodosomals; first three pairs of dorsal hysterosomal setae very long, nearly as long as third dorsal propodosomals . . . . *laminifer,* p. 1169

Second and fourth dorsal propodosomals with length subequal to setae of first pair; dorsal hysterosomal setae short, much shorter than third dorsal propodosomals . . . . *dispar,* p. 1148

11. Third dorsal propodosomal setae very long, much longer than setae of other three pairs 12

Third dorsal propodosomals not excessively longer than others . . 14

12. Femur IV dilated and robust, broadest at mid-segment, here with width greater than half length of segment; tactile seta of tibia IV much longer than other setae of leg IV . . . . *smithi,* p. 1141

Femur IV broadest near base, width at mid-segment much less than half length of segment; tactile seta of tibia IV exceeded in length by at least one other seta on leg 13

13. Femur IV more than twice as long as broad at base; tactile seta of tibia IV about two thirds as long as femur IV . . . *randsi,* p. 1133

Femur IV about one and one-half times as long as broad at base; tactile seta of tibia IV nearly as long as femur IV . . . . . . *unguis,* p. 1210

14. Tactile seta of tibia IV much longer than femur IV . . . . *texanus,* p. 1196

Tactile seta of tibia IV two thirds as long as femur IV . . . . . *waitei,* p. 1181

Tarsonemus occidentalis Ewing

(Plates 11, 18 and 23)

Tarsonemus occidentalis Ewing, 1939, U.S.D.A. Tech. Bull., 653, p. 21.

Male: Body elongate oval, broadest slightly anterior to forward condyles of coxae III, tapering gently anterior and abruptly posterior from this point. Apodemes conspicuous and well defined. Apodemes I as long as width of femur I, extending from inner angles of coxae I in posteromedial direction, converging medially about one third medial distance between inner angles of coxae I and II. Anterior median apodeme extending from point of juncture of apodemes I to main body suture. Apodemes II subparallel to apodemes I, about twice as long as the latter, extending from inner angles of coxae II and joining median apodeme at its posterior third. Transverse apodeme extending in anteromedial direction from anterior condyles of coxae III, terminating anteriorly two thirds the distance to main body suture. Apodemes IV subparallel to apodemes III, extending from outer basal condyles of coxae IV two thirds the distance to main body suture. Posterior median apodeme extending from point in line with bases of apodemes IV to point just behind anterior extremities of apodemes IV, this anterior extremity being trifurcate. Posterior interapodemal areas each bounded anteriorly by indistinct, convex apodemes forming scalloped anterior margin of total area. Propodosoma three fourths as long as broad at base, lateral margins deeply incurved slightly anterior to mid-lengths; narrow cephalothoracic shield projecting anterior to this point covering basal half of capitulum, the anterior margin of shield rounded truncate. Dorsum of hysterosoma divided transversally by a conspicuous suture at posterior fifth. *Dorsal chaetotaxy:* Propodosoma with first three pairs of setae arranged in a longitudinal row, setae of fourth pair between third pair and lateral margins of body; first pair of setae as long as combined lengths of femur and genu II, separated from each other by a distance slightly more than one half length of seta, located one half length of seta behind apex of cephalothoracic shield; second pair of setae nearly as long as first pair, located one half length of seta behind and slightly laterad from first pair, setae separated from each other by a distance equal to length of seta; third pair of setae nearly as long as width of body at main body suture, located the length of genu I in front of main body suture, the same distance from lateral margins of body at this point; fourth pair of dorsal propodosomal setae as long as first pair, located one fourth length of seta immediately laterad from setae of third pair. Hysterosoma with first pair of dorsal setae as long as coxa III, situated on lateral margins of body midway between anterior condyles of coxae III and main body suture; second pair of setae slightly shorter and stouter than first pair, located near lateral margins of body one half length of seta in front of posterior hysterosomal suture; third pair of setae slightly shorter than second pair, situated two thirds length of seta medial and slightly posterior to setae of second pair, this location being one third length of seta anterior to hysterosomal suture; fourth pair of dorsal hysterosomal setae one half as long as second pair, located between anterior third of genital papilla and lateral body margins. *Ventral chaetotaxy:* Propodosoma with first pair of setae as long as width of genu I, located the length of seta laterad from anterior extremity of median apodeme; second pair of setae slightly longer than first pair, situated twice length of seta laterad from median apodeme at point of juncture of apodemes II. Hysterosoma with first pair of setae slightly longer than tibia III, located just medial to anterior extremity of apodemes III; second pair of ventral hysterosomal setae slightly longer than first pair, situated just laterad from apodemes IV in line with anterior condyles of coxae III. *Capitulum:* Length including projecting palpi, 26μ; width, 22μ; subcordate with posterior margin rounded truncate. Dorsal setae two thirds as long as tibia I, separated from each other by a distance equal to width of tibia I at base; ventral setae nearly as long as dorsal setae. Palpi and chelicerae projecting slightly beyond apex of capitulum, palpi indistinctly segmented; cheliceral sheaths without conspicuous strandlike thickenings. *Legs:* Anterior pairs elongate robust, similar in size and shape. Leg I with coxa subquadrangular, slightly broader than long, without setae; femur as long as distance between inner coxal condyles of legs I and II, about twice as long as broad, with three setae; genu two-thirds as long as femur, about one and one-fourth times as long as broad, with four normal setae; tibia slightly longer than genu, about twice as long as broad, with five normal setae and one clavate, annulated seta, the latter two thirds as long as basal width of segment and located near outer margin slightly proximad to mid-segment; tarsus as long as tibia, tapering slightly to broadly rounded apex, with one clavate, annulated seta nearly as long as basal width of segment, located dorsally near outer margin at basal fifth, one dorsal, peglike seta one third as long as annulated seta, located just medial to annulated seta, eight normal setae; tarsus surmounted by a short, narrow pretarsus bearing at its apex a broad empodium beyond which projects a single, stout, curved claw. Leg II with coxa subquadrangular, about as broad as long, without setae; femur about as long as femur I, one and one-half times as long as broad, tapering slightly to apex, with three setae; genu one half as long as femur, about as broad as long, with three setae; tibia slightly longer than genu, about one and one-third times as long as broad at base, tapering slightly from base to apex, with four setae; tarsus as long as tibia, two and one-half times as long as broad at base, tapering to broadly rounded apex, with four normal setae and two specialized setae, one of the latter clavate and annulate, its length almost equal to width of segment at base, located dorsally near outer margin at base, the other peglike, with length equal to half basal width of segment, located dorsally near outer margin at basal third; tarsus surmounted by a narrow pretarsus as long as the basal width of tarsus, bearing at its apex two strong, curved, spreading claws between and beyond which projects a broad, bilobed empodium. Legs III with coxae widely separated, posterolateral angles projecting beyond body margins, length of coxa equal to combined lengths of genu and tibia II, nearly twice as long as greatest width, without setae; femur as long as combined lengths of genu and tibia II, outer margin concave medially, basal half of segment expanded bulbous, segment with one seta located on outer margin at apical third; genu slightly more than half as long as femur, one and one-half times as long as broad, with three setae; tibia one and one-third times as long as genu, twice as long as broad, with four setae; tarsus slightly shorter than tibia, tapering from base to broadly rounded apex, with three setae; tarsus surmounted by a narrow pretarsus, as long as the width of tibia, bearing at its apex two strong, curved, spreading claws between which projects a broad empodium. Leg IV with coxa subquadrangular, broader than long, with one seta having length equal to two thirds width of segment, located ventrally at outer apical angle of segment; femur slightly longer than the distance between inner condyles of coxae II, length about twice greatest width of segment, width of femur at apex equal to half width at base, outer margin strongly convex, inner margin nearly straight and incurved at a pronounced angle near base, a prominent suture extending from inner margin the distal width of segment before apex to outer apical angle, segment with one dorsal seta having a length nearly equal to length of segment situated near outer margin at its mid-length, one ventral seta one half as long as segment located near inner margin just proximad to juncture of diagonal suture with inner lateral margin of segment, one seta with length slightly less than apical width of segment located ventrally on inner margin slightly proximad to mid-segment; tibia one and one-third times as long as broad at base, outer margin slightly convex, inner margin with a short, shallow, concave notch in a medial position on the margin, segment with one lanceolate seta as long as apical width of segment located dorsally near outer margin just before apex, one strong seta about two and one-half times as long as segment located ventrally near outer margin just before apex; tarsus short, nearly twice as broad as long, with one seta as long as width of segment located dorsally on inner margin just before apex, one seta as long as width of segment located ventrally on inner margin at apex, one short seta as long as segment situated middorsally at apex; tarsus surmounted by a broad, curved, pointed claw two thirds as long as tibia. *Genital papilla:* Length, 29μ; width, 25μ; subcordate, anterior margin emarginate, a conspicuous suture transecting papilla at its apical third. *Anal plate:* Conspicuous and well defined; anal orifice oval in shape, largest diameter equal to basal width of tarsus III, with three radiating apodemes, the median apodeme as long as basal width of tarsus III, extending from caudal margin of center ring one half the distance to anterior margin of genital papilla, anterior apodemes as long as genu III, spreading a distance equal to two thirds width of genital papilla. *Measurements:* Length from tip of capitulum to apex of genital papilla, 158μ; main body suture to apex of genital papilla, 96μ; anterior margin of cephalothoracic shield to main body suture, 49μ; width of body at main body suture, 69μ; width immediately in front of anterior apodemes of coxae III, 81μ.

Female: Body broadly oval, broadest at mid-length. Apodemes distinct and well defined. Apodemes I as long as genu I, extending from inner angles of coxae I in posteromedial direction, converging at mid-body at point opposite mid-distance between inner angles of coxae I and II. Apodemes II subparallel to apodemes I, extending from inner angles of coxae II, converging medially midway between anterior extremity of median apodeme and main body suture, basal third of apodemes indistinct, recurved. Anterior median apodeme clearly defined from anterior extremity at intersection with apodemes II to point of juncture with curved medial extremities of apodemes II, less distinct posterior from this point to its indistinct terminus midway between hind extremities of apodemes II and main body suture. Transverse apodeme conspicuous and well-defined, transecting body ventrally, apodeme discontinuous in medial zone for a distance nearly equal to the length of apodeme II. Apodemes III one third as long as coxa III, extending in an anteromedial direction from anterior condyles of coxae III. Apodemes IV slightly longer than coxae III, extending in an anteromedial direction from points slightly mesad and anterior to inner apical angles of coxae III, apodemes with a slight indentation at about mid-length, terminating just before juncture with median apodeme at point nearly in line with anterior extremities of coxae III. Posterior median apodeme extending mid-ventrally from a point in line with hind extremities of coxae III to a point nearly in line with basal extremities of coxae III, apodeme bifurcate at this point with each arm extending for a short distance in anterolateral direction; each fork at anterior extremity of apodeme having a length equal to the distance from base of fork to point nearest anterior extremities of apodemes IV. Hysterosoma transected dorsally by five sutures, the first at about anterior third of coxa III; second suture at posterior extremities of coxae III; third suture about one fourth distance from coxae IV to apex of body; fourth suture two thirds distance from third suture to apex of body; fifth suture midway between fourth suture and apex of body. Cephalothoracic shield not prolonged, anterior margin truncate and barely extending over base of capitulum. Pseudostigmatic organs short; length including pedicel equal to length of genu I, expanded apex oval, about twice as long as the narrow pedicel;

basal plates associated with areolus consisting of two heavily sclerotized, rectangular sclerites as long as the greatest width of organ at its apex. Stigmatal openings and tracheae obscure. *Dorsal chaetotaxy:* Propodosoma with first pair of setae as long as width of capitulum, located one third length of seta behind anterolateral angles of cephalothoracic shield, separated from each other by a distance equal to three fourths length of seta; second pair of setae with length equal to one half width of body at main body suture, one half length of seta from lateral margins of body. Hysterosoma with first pair of setae nearly as long as femur I, located near lateral margins of body one half length of seta behind main body suture; second pair of setae slightly longer than first pair, located one and one-half times length of seta from lateral margins of body, one half length of seta anterior to first hysterosomal suture, this position being slightly behind anterior condyles of coxae III; third pair of dorsal hysterosomal setae as long as but stouter than setae of second pair, located one and one-third times length of seta from lateral body margins, one fourth length of seta anterior to third hysterosomal suture, separated from each other by a distance equal to two and one-half times length of seta; fourth pair of setae slightly shorter than third pair, located on lateral margins of body just anterior to fourth hysterosomal suture; fifth pair of setae slightly longer than third pair, situated on anterior margin of penultimate segment, separated by a distance equal to length of seta; sixth pair of setae slightly shorter than fifth pair, located near base of apical segment of hysterosoma on lateral margins of body, setae separated from each other by a distance equal to twice length of seta. *Ventral chaetotaxy:* Propodosoma with first pair of setae as long as width of genu I, located slightly behind apodemes I at their mid-lengths; second pair as long as genu II, located on posterior margins of apodemes II at their anterior thirds. Hysterosoma with first pair of setae as long as tarsus II, located slightly more than the length of seta behind main body suture, one half length of seta laterad from forward extremities of anterior forks of median apodeme; second pair of setae as long as first pair, located on lateral margins of apodemes IV just before their posterior extremities; third pair of ventral hysterosomal setae as long as the greatest width of coxa III, located at apex of opisthosoma, separated from each other by a distance equal to one and one-half times length of seta. *Capitulum:* Length including projecting palpi, 34μ; width, 28μ; subcordate with posterior margin slightly emarginate. Median dorsal apodeme extending entire length of capsule, unbranched. Dorsal setae as long as genu II, located near apex of capitulum, separated from each other by a distance equal to length of seta; ventral setae as long as dorsal setae. Palpi robust, two-segmented, projecting a short distance beyond apex of capitulum. Chelicerae projecting slightly beyond apex of capitulum; cheliceral sheaths with conspicuous spiral thickenings. *Legs:* Anterior pairs elongate, robust. Leg I with coxa subquadrangular, one and one-third times as broad as long, without setae; femur two thirds as long as greatest width of capitulum, twice as long as broad, inner margin incurved at basal third, segment with three setae; genu two thirds as long as femur, one and one-half times as long as broad, lateral margins subparallel, with three setae; tibiotarsus as long as femur, about three and one-half times as long as broad at base, tapering from base to broadly rounded apex, with one short, clavate, annulated seta having a length equal to one half basal width of segment located dorsally on outer margin the length of seta from base, one long, clavate, annulated seta as long as the basal width of segment located dorsally near outer margin at mid-segment, ten normal setae; tibiotarsus surmounted by a short pretarsus with length equal to one third basal width of tarsus, bearing at its apex a broad empodium beyond which projects a single, strong, curved claw. Leg II with coxa subquadrangular, one and one-third times as broad as long, without setae; femur short, nearly as broad as long, one and one-half times as broad as femur I, having length about equal to length of femur I, with three setae; genu less than one half as long as femur, width at base equal to length, lateral margins converging slightly, with one stout, lanceolate seta as long as segment located dorsally near outer margin at base, two normal setae; tibia slightly longer than genu, one and one-half times as long as broad at base, lateral margins somewhat convex, segment with three setae; tarsus narrow, rugose, about twice as long as broad at base, tapering from base to apex, length equal to length of tibia, with one annulated, clavate seta with length equal to two thirds basal width of segment located dorsally near outer margin one half length of seta from base of segment, one short, stout spine with length equal to one half basal width of segment, the diameter of spine at base nearly equal to its length, located on outer margin at base of segment, three normal setae; tarsus surmounted by a short pretarsus with length equal to one half basal width of tarsus, and bearing at its apex two strong, spreading, curved claws between which projects a broad empodium. Leg III with coxa narrow, elongate, length nearly equal to twice length of tibia, broadest at anterior fourth, its greatest breadth about one fourth length of segment, without vestiture; femur slightly more than one half as long as coxa, constricted at basal third, proximal third of segment bulbous, distal two thirds of segment with lateral margins divergent to apex, width at apex equal to one third length of segment, segment with three setae; tibia as long as femur, about three times as long as broad at base, tapering slightly to apex, with four normal setae; tarsus narrow, elongate, two thirds as long as tibia, nearly five times as long as broad at base, with three setae; tarsus surmounted by a narrow, elongate pretarsus nearly one half as long as tarsus, bearing at its apex two strong, curved, spreading claws and a broad empodium. Leg IV with coxa subquadrangular, slightly longer than broad, length equal to apical width of femur III, without setae; trochanter small, collarlike, broader than long, without vestiture; third segment narrow, elongate, length equal to transverse distance between anterior coxal condyle of leg III and posterior median apodeme, one ventral seta nearly one-half as long as segment situated near outer margin one half basal width of segment from base, one stout seta one half as long as segment located ventrally near outer margin the basal width of segment before apex; fourth segment nearly one half as long as third segment, lateral margins subparallel, with one stout, mid-ventral seta as long as third segment situated the width of fourth segment before apex, one terminal seta longer than leg IV. *Measurements:* Apex of capitulum to tip of opisthosoma, 212μ; anterior margin of cephalothoracic shield to main body suture, 66μ; main body suture to tip of opisthosoma, 121μ; width of body at main body suture, 103μ; width at anterior coxal condyles of legs III, 119μ; distance between anterior coxal condyles of legs III, 56μ.

Types: Sumner, Washington, Mar. 22, 1934, F. F. Smith, on *Fragaria* sp. One slide mounting five females and two males; one of the males ringed by the present author and herewith designated lectotype.

Location of types: United States National Museum No. 1121.

Material examined by this writer in addition to the type series included slides with the following data: Males and females, De Faures, Ohop Creek, Eatonville, Wash., Nov. 12, 1934, Wm. W. Baker, *Eriophyes* gall on *Salix* sp.; De Faures, South Prairie, Wash., Oct. 26, 1934, Wm. W. Baker, evergreen blackberry; De Faures, Skamokawa, Wash., Oct. 16, 1934, Wm. W. Baker, evergreen blackberry; De Faures, South Bend, Wash., Oct. 17, 1934, Wm. W. Baker, evergreen blackberry; Quinault, Wash., Oct. 20, 1933, Wm. W. Baker, apple; De Faures, Puyallup, Wash., Nov. 26, 1934, Wm. W.

Baker, *Spiraea douglasi;* Osceola, Wash., Sept. 13, 1933, Wm. W. Baker, evergreen blackberry; De Faures, Puyallup, Wash., Aug. 18, 1934, evergreen blackberry; Puyallup, Wash., Aug. 8, 1934, Wm. W. Baker; Puyallup, Wash., Sept. 30, 1933, Wm. W. Baker, strawberry; Puyallup, Wash., July 25, 1933, Wm. W. Baker, native dewberry; De Faures, Puyallup, Wash., Oct. 9, 1934, Wm. W. Baker, *Corylus californica.*

The female of this species very closely resembles *T. smithi,* the most conspicuous distinguishing characters being the continuation of apodemes II posteriorly to a juncture with the anterior median apodeme and the interruption of the transverse apodeme mesally; also the bifurcate anterior extremity of the posterior median apodeme. It may be distinguished from *T. setifer* in male characters by the short tactile seta of tibia IV and in females by the absence of the dorsal propodosomal apodeme.

Tarsonemus setifer Ewing

(Plates 9, 18 and 23)

Tarsonemus setifer Ewing, 1939, U. S. Dept. Agr. Tech. Bull., 653, p. 19.
Tarsonemus bakeri Ewing, 1939, U. S. Dept. Agr. Tech. Bull., 653, p. 20; McGregor, 1942, California Citrograph, vol. 27, no. 10, p. 270; McGregor, 1944, California Citrograph, vol. 30, no. 2, p. 53. (new synonymy.)

Male: Body broad, oval, broadest at anterior coxal condyles of legs III, tapering abruptly to apex of opisthosoma and gently to apex of propodosoma. Apodemes conspicuous and well defined. Apodemes I as long as width of genu I, converging medially at point in line with posterior angles of coxae I, terminating anteriorly at inner condyles of coxae I. Apodemes II about twice as long as apodemes I, extending from inner condyles of coxae II in posteromedial direction, terminating just before juncture with median apodeme. Anterior median apodeme well defined from its anterior extremity at juncture of apodemes I to a point almost in line with medial extremities of apodemes II, narrowed and less distinct beyond this point to its posterior extremity just before main body suture. Posterior apodemes nearly parallel for most of their lengths, converging slightly anteriorly. Apodemes III extending from anterior condyles of coxae III in anteromedial direction for slightly more than one half the distance to main body suture. Apodemes IV extending from outer basal angles of coxae IV in a direction nearly parallel to apodemes III, terminating anteriorly midway between anterior extremities of apodemes III and median apodeme. Posterior median apodeme with its anterior extremity nearly in line with anterior extremities of apodemes III and IV, extending caudad from this point for two thirds the distance to inner basal angles of coxae III where apodeme divides, each fork continuing to inner, basal, coxal angles of legs IV. Posterior apodemes connected anteriorly by rather inconspicuous, transverse apodemes which present a scalloped anterior margin to the interapodemal area, each interapodemal area broadest posteriorly with anterior limit rounded truncate. Cephalothoracic shield absent. *Dorsal chaetotaxy:* Propodosoma with first three pairs of setae arranged in a longitudinal row, setae of fourth pair located almost directly laterad from setae of third pair; first pair of setae nearly as long as capitulum, located in line with inner angles of coxae I and separated from each other by a distance equal to half length of seta; second pair of setae three fourths as long as first pair, located two thirds length of seta behind and slightly laterad from first pair, about in line with posterior angles of coxae I; third pair of setae as long as width of body at main body suture, located the width of tibia II behind and slightly laterad from setae of second pair; fourth pair of dorsal propodosomal setae as long as first pair, located the basal width of tarsus II laterad from and slightly behind setae of third pair. Hysterosoma with first pair of setae as long as combined lengths of genu and tibia III, located near lateral margins of body midway between anterior condyles of coxae III and main body suture; second pair of setae slightly longer and stouter than first pair, located near lateral margins of body one third length of seta behind anterior extremities of coxae III; third pair of setae three fourths as long as second pair, situated two thirds length of seta from lateral margins of body nearly in line with anterolateral angles of coxae IV; fourth pair of setae about one half as long as third pair, located beside lateral margins of genital papilla at its anterior fourth. *Ventral chaetotaxy:* Propodosoma with two pairs of ventral setae, first pair minute, length equal to basal width of tarsus I, located the length of seta directly laterad from anterior extremity of median apodeme; second pair as long as genu I, situated about two thirds length of seta behind mid-lengths of apodemes II. Hysterosoma with first pair of setae two thirds as long as tibia III, situated medially in interapodemal area defined by apodemes III and IV just behind anterior limit of area; second pair of setae subequal in length to first pair, located in same interapodemal area close to apodemes IV, in line with anterior extremities of coxae III. *Capitulum:* Length including projecting palpi, 33μ; width, 28μ; subcordate with posterior margin rounded truncate. Apodemes not clearly defined. Dorsal and ventral setae about the same distance behind apex of capitulum, the latter slightly longer than the former. Palpi and chelicerae extending beyond apex of capitulum, bases of cheliceral sheaths with faint transverse striations. *Legs:* Anterior pairs subequal in size and shape, legs I slightly longer than legs II. Leg I with coxa subquadrangular, one and one-third times as broad at base as long, tapering from base to apex, without setae; femur short, one and one-fourth times as long as greatest breadth, outer margin twice as long as inner margin and incurved at basal third, with three normal setae; genu two thirds as long as femur, as broad as long, lateral margins subparallel, segment with four setae; tibia one and one-fourth times as long as genu, twice as long as broad, lateral margins subparallel, with five normal setae and one short, clavate seta with length equal to one third width of segment, located dorsally near outer margin at mid-segment; tarsus as long as tibia, about three times as long as broad at base, tapering from base to apex with seven normal, one bristlelike and one clavate setae, the latter annulated and three fourths as long as basal width of segment, situated middorsally the length of seta from base of segment, the bristlelike seta two thirds as long as the clavate seta and located dorsally near outer margin at about mid-segment; tarsus surmounted by a strong, curved claw the apex of which projects beyond a broad, subcircular empodium. Leg II with coxa subquadrangular, one and one-half times as broad as long, without setae; femur short, slightly longer than greatest breadth, inner margin less than one half as long as outer margin, with three setae; genu two thirds as long as femur, as broad as long, with three setae; tibia one and one-third times as long as genu, nearly twice as long as broad, with four setae; tarsus as long as tibia, about three times as long as broad at base, tapering abruptly from base to narrowly rounded apex, with one short, broad, annulated seta twice as long as broad, its length equal to two thirds basal width of segment, located dorsally near inner margin one half length of seta from base of segment, three normal setae; tarsus terminated by a short, narrow pretarsus bearing at its apex two strong, curved, spreading claws between and beyond which projects a broad, bilobed empodium. Leg III with coxa subtriangular, nearly twice as long as broad, length equal to combined lengths of genu and tibia III, anterior extremity a distance equal to combined lengths of last four segments of leg III behind main body suture, segment without vestiture; femur two thirds as long as coxa, about twice as long as broad, basal third of segment subglobose, with one dorsal seta one half as long as segment located on outer margin at apical third of segment; genu slightly more than one half length of femur, slightly longer than broad, lateral margins subparallel, with three setae; tibia one and one-third times as long as genu, twice as long as broad, segment with four normal setae; tarsus about as long as tibia, tapering from base to apex, with two setae; tarsus surmounted by a narrow pretarsus, one third as long as tarsal segment, bearing apically two strong, curved, spreading claws between and beyond which projects a broad, bilobed empodium. Leg IV with coxa subquadrangular, about one and one-half times as broad as long, with one ventral seta as long as segment located one third length of seta from outer margin at apical third of segment; femur long, robust, about two and one-half times as long as greatest breadth, broadest at basal third, width at apex about one half width at basal third, outer margin convex, inner margin straight for most of its length, curved inward at basal fourth, segment with one weak dorsal seta nearly as long as greatest width of segment and located near outer margin two thirds length of seta before apex of segment, one ventral seta with length equal to apical width of segment located on inner margin just proximad to mid-segment, one strong dorsal seta one half as long as segment located near inner margin a distance equal to apical width of segment before apex; tibia about twice as long as broad at base, outer margin straight, inner margin concave, with one long tactile seta, longer than leg IV, situated midventrally at apical fifth of segment, one peglike seta nearly as long as apical width of segment located dorsally near outer margin one half length of seta before apex; tarsus short, about twice as broad as long, with one spinelike seta as long as basal width of claw located dorsally near outer margin at apex of segment, one seta two thirds as long as tibia located dorsally near inner margin at apex, one seta two thirds as long as tibia located ventrally near inner margin at apex of segment; tarsus bearing at its apex a strong, gently curved claw two thirds as long as tibia. *Genital papilla:* Length, 30μ; width, 29μ; subcordate, anterior margin rounded truncate with narrow cleft medially; posterior half of papilla projecting beyond tip of opisthosoma. *Anal plate:* Situated a distance equal to one third width of genital papilla in front of anterior margin of the latter; circular medial orifice with a diameter equal to two thirds basal width of tarsus III, radiating apodemes of equal length and as long as basal width of tibia III. *Measurements:* Length from tip of capitulum to apex of genital papilla, 175μ; main body suture to apex of genital papilla, 103μ; width at main body suture, 76μ; width of body at coxae III, 90μ.

Female: Body broadly oval, broadest at mid-length. Anterior apodemes distinct, those of legs I extending from inner angles of coxae I in posteromedial direction converging medially at a point midway between inner angles of coxae I and II. Apodemes II extending from inner angles coxae II in a direction subparallel to apodemes I, joining median apodeme at a point about in line with hind margins of coxae II; apodemes well defined at anterior two thirds, less distinct at posteromedial third. Anterior median apodeme extending from anterior extremity at Y-juncture of apodemes I to main body suture, indistinct at region of juncture of apodemes, and at posterior extremity from main body suture half the distance to juncture of apodemes II. Transverse apodeme clear and well-defined, extending nearly the width of body, its length broken for a short distance at two points the basal width of tarsus II laterad from mid-line. A small dorsal apodeme located medially on propodosoma the basal width of tarsus II anterior to main body suture, apodeme extending medially anterior from this point for distance equal to its distance from main body suture, two laterally directed curved forks extending from its posterior extremity, each slightly longer than median portion of apodeme. Posterior apodemes inconspicuous, those of legs III less than one half as long as coxae III, extending in anteromedial direction from forward extremities of coxae III; apodemes IV appearing as thin lines about as long as apodemes I, posterior extremities situated two thirds the length of apodemes mesad from inner margins of coxae III at their basal thirds extending in anteromedial directions from these points, their anterior extremities about in line with anterior thirds of coxae III and separated from each other by a distance nearly equal to twice length of apodeme. Posterior median apodeme absent. Hysterosoma divided dorsally by six indistinct transverse sutures. Cephalothoracic shield rounded truncate, covering basal third of capitulum. Pseudostigmatic organs with expanded apices subcircular, nearly as broad as long; pedicels narrow, elongate, as long as expanded apices; basal plates with two semicircular, heavily sclerotized areas nearly as long as greatest width of apex of organ, situated immediately above inner angles of coxae II. Stigmatal openings located on pronounced dorsolateral expansions situated just behind anterior extremity of cephalothoracic shield; tracheae indistinct. *Dorsal chaetotaxy:* Propodosoma with first pair of setae nearly as long as greatest width of capitulum, located one third length of seta behind anterolateral margins of cephalothoracic shield, this distance mesad to lateral margins of body; second pair of setae slightly longer than width of body at main body suture, located the basal width of tarsus II behind basal ring of pseudostigmatic organs, this being about one fourth the distance from basal plates of organs to transverse apodeme. Hysterosoma with first pair of setae two-thirds as long as coxa III, located one third length of seta from lateral margins of body, about midway between main body suture and anterior extremities of coxae III; setae of second pair one third as long as first pair, located immediately above and slightly mesad to anterior condyles of coxae III; third pair of setae stout, slightly longer than second pair, located one third length of seta behind coxae IV and separated from each other by a distance equal to three times length of seta; fourth pair of setae nearly as long as third pair, located two thirds length of seta from lateral margins of body, about midway between coxae IV and tip of opisthosoma; fifth pair of setae as long as tarsus III, located in line with fourth pair of setae, separated from each other by a distance one and one-half times length of seta and separated from setae of fourth pair by an equal distance; sixth pair of setae two thirds as long as fifth pair, situated on body margins the length of seta before apex, setae separated from each other by a distance equal to four times length of seta. *Ventral chaetotaxy:* Two pairs of ventral setae on propodosoma; first pair minute, length equal to two thirds basal width of tarsus II, located on apodemes I at their mid-lengths; second pair as long as genu II, located just behind mid-points of apodemes II. Hysterosoma with first pair of setae one and one-half times as long as apical segment of leg IV, located one third length of seta medial to anterior extremities of apodemes III; second pair of setae as long as first pair, located at hind extremities of apodemes IV; third pair of seta slightly shorter than second pair, located at apex of opisthosoma, setae separated from each other by a distance equal to one and one-half times length of seta. *Capitulum:* Length including projecting palpi, 41μ; greatest width, 35μ; caudal margin very slightly concave. Dorsal setae as long as width of genu I, separated from each other by a distance equal to one and one-fourth times length of seta, situated in line with ventral setae, the latter as long as dorsal setae. Palpi short, broad, two-segmented; chelicerae projecting slightly beyond apex of capitulum, cheliceral sheaths not striate. Dorsal, longitudinal, median apodeme nearly as long as capitulum, lateral branches broad, well-defined, extending from mid-lateral margins to posterior extremity of medial apodeme. *Legs:* Anterior pairs elongate, robust. Leg I with coxa subquadrangular, one and one-half times as broad as long, without setae; femur short, about one and one-third times as long as greatest breadth, inner margin one half as long as outer margin, segment with three setae; genu one and one-third times as long as broad, tapering slightly from base to apex, with four normal setae; tibiotarsus broad, elongate, one and one-half times as long as genu, three times as long as broad at base, tapering slightly to broadly rounded apex, with one peglike seta having length equal to basal width of segment, situated dorsally near outer margin at basal fifth of segment, one small, clavate, annulated seta with length equal to one half basal width of segment, situated middorsally at basal fourth, one clavate, annulated seta as long as basal width of segment, located middorsally slightly distad to mid-segment, ten normal setae; tarsus surmounted by a short, narrow pretarsus bearing at its apex a long, curved claw which projects beyond a broad empodium. Leg II with coxa subquadrangular, about one and one-half times as broad as long, without setae; femur short, slightly longer than broad, with two setae, first seta lanceolate, its length equal to one half apical width of segment, located dorsally at mid-point on inner margin, second seta as long as greatest width of segment located dorsally near outer margin at mid-segment; genu broader than long, with two normal setae and one strong, lanceolate seta, the latter slightly longer than segment and located dorsally near inner margin at base; tibia one and one-fourth times as long as broad, about as long as genu, with four setae; tarsus one and one-fourth times as long as tibia, tapering abruptly to its narrowly rounded apex, with one clavate, annulated seta having a length nearly equal to basal width of segment, located dorsally near inner margin at base, one stout, lanceolate seta one third as long as segment located ventrally near inner margin at mid-segment, one short, broad, lanceolate seta with length equal to one third basal width of segment located ventrally near inner margin the length of seta before apex, two normal setae; tarsus surmounted by a narrow pretarsus, nearly as long as basal width of tarsus, bearing at its apex two strong, spreading, curved claws between which projects a broad empodium. Leg III with coxa broad, elongate, about three and one-half times as long as greatest breadth, inner and outer margins convex, segment as long as combined lengths of genu and tibiotarsus I, without vestiture; femur slightly more than one half as long as coxa, bulbous at basal third, slightly expanded apically, with three normal setae; tibia as long as femur, about three times as long as broad, tapering slightly from base to apex, with four setae; tarsus narrow, elongate, three fourths as long as tibia, lateral margins subparallel, segment with three setae; tarsus surmounted by a narrow pretarsus one half as long as tarsal segment, supporting at its apex two strong, spreading, curved claws between which projects a broad empodium. Leg IV with coxa subquadrangular, slightly longer than broad, lateral margins convex, without setae; trochanter collarlike, broader than long, without setae; third segment narrow, elongate, length equal to one half distance between anterior coxal condyles of legs III, with one seta one fifth as long as segment located ventrally near outer margin about two thirds length of seta from base, one ventral seta as long as segment located near outer margin the apical width of segment before apex; fourth segment slightly more than one fourth as long as third segment, with one stout, ventral seta about three times as long as segment located near outer margin the width of segment before apex, one apical seta about twice as long as leg IV. *Measurements:* Apex of cephalothoracic shield to tip of opisthosoma, 204μ; tip of shield to main body suture, 61μ; width of body at main body suture, 99μ; width at anterior coxal condyles of legs III, 134μ; distance between anterior coxal condyles of legs III, 63μ.

Types: Nest View (Pittsburgh), Pa., Nov. 2, 1933, F. F. Smith, on chrysanthemum. One of the male specimens has been encircled by the present author and is here designated lectotype.

Location of types: United States National Museum No. 1119; slide with two males, several females.

Material examined by this writer in addition to the type series included specimens with the following data: Santa Paula, Calif., Oct. 1945, C. J. Barrett, orange buttons; De Faures, Oak Point, Wash., Oct. 18, 1934, Wm. W. Baker, *Rubus leucodermis;* San Jose, Calif., Dec. 20, 1934, raspberry buds; Puyallup, Wash., Sept. 8, 1933, Wm. W. Baker, evergreen blackberry; Puyallup, Wash., Oct. 4, 1933, Wm. W. Baker, evergreen blackberry; Himalaya, Tacoma, Wash., Sept. 22, 1931, Wm. W. Baker; Sumner, Wash., Sept. 16, 1931, S. E. Crumb, in blackberry; Santa Paula, Calif., 1939, lemon; Riverside, Calif., Mar. 19, 1938, K. Maxwell, on pomegranate leaf and bud scales; Whittier Lab., Calif., Apr. 1, 1943, Munger, on old lemon from lath house; Corona, Calif., Mar. 9, 1942, E. A. McGregor, on lemon; Santa Paula, Calif., June 30, 1937, A. M. Boyce, in lemon buds; Selma, Calif., Feb. 24, 1940, S. F. Bailey, on peach; La Habra, Calif., Sept. 18, 1937, E. A. McGregor, in lemon buds; U. C. campus, Berkeley, Calif., Oct. 11, 1949, R. E. Beer, verbena; San

Francisco, Calif., Oct. 12, 1949, S. E. Hall, monterey pine infested with phytoptipalpids; Roger Reynolds' Nursery, Atherton, San Mateo Co., Calif., Nov. 1, 1949, R. E. Beer, bamboo infested with *Antonina* sp.; U. C. greenhouse, Berkeley, Calif., Oct. 20, 1949, R. E. Beer, *Tradescantia* sp.; John Edwards' Nursery, Palo Alto, Calif., Nov. 1, 1949, R. E. Beer, dead leaves of daphne; Plath's Nursery, San Francisco, Calif., Sept. 29, 1949, R. E. Beer, quack grass.

In general appearance living mites are opaque white or amber colored. Indications are that it is a very common species, and in areas collected by this author *T. setifer* was encountered more frequently than any other species of tarsonemid mite. Specimens have been reared through several generations in agar slant cultures of fungus. Because of their rather large size in comparison to other species, their relative abundance and ease of obtaining specimens, together with the comparative ease of rearing the mites, this species lends itself well to biological studies. In one experiment conducted by this writer males of this species were observed portaging male "pupae" of *T. pritchardi*.

T. bakeri is obviously a synonym of *T. setifer;* the figures for the two species in the publication containing original descriptions of each present no dissimilarities of note, and the type specimens of *T. bakeri* agree in every detail with those of *T. setifer*.

Although males and females of *T. setifer* very closely resemble *T. occidentalis,* the short tactile seta of femur IV in the male *T. occidentalis* and the presence of a small dorsal propodosomal apodeme in the female *T. setifer* quickly separates both sexes of these species. The male of *T. setifer,* in addition to the characters indicated in the key, further differs from *T. smithi* in the location of the first pair of ventral hysterosomal setae, which appear on the anterior margins of the interapodemal areas defined by apodemes III and IV rather than well behind these margins as occurs in *T. smithi*.

Tarsonemus randsi Ewing

(Plates 11, 18 and 23)

Tarsonemus randsi Ewing, 1939, U. S. Dept. Agr. Tech. Bull., 653, p. 25.
Tarsonemus iowensis Ewing, 1939, U. S. Dept. Agr. Tech. Bull., 653, p. 48. (new synonymy.)

Male: Body moderately elongate, oval, broadest at posterior two fifths in line with anterior extremities of coxae III; apodemes strong and well defined; genital papilla large, larger than capitulum; anal plate rather small but distinct. Apodemes I nearly as long as genu I, extending in posteromedial directions from innermost angles of coxae I, converging medially to form a Y-shaped juncture with anterior extremity of median apodeme. Apodemes II strong, slightly more than twice as long as apodemes I and subparallel to the latter, their mesal extremities not quite contacting median apodeme and located a short distance anterior to transverse apodeme. Transverse apodeme not as strong as other apodemes of the propodosoma but distinct for its entire length, less distinct medially than laterally, transecting body just in front of main body suture. Anterior median apodeme distinct for most of its length, interrupted for a short distance only just anterior to posterior extremities of apodemes II, extending from transverse apodeme to point of convergence of apodemes I. Apodemes III extending in anteromedial directions from anterior condyles of coxae III, curving smoothly inward at anterior thirds to join apodemes IV. Apodemes IV extending anteromedially in a nearly straight line from outer basal condyles of coxae IV to point of juncture with apodemes III, looping forward and mesally from this point to converge at anterior extremity of median apodeme. Posterior median apodeme strong and distinct for its entire length, extending from point of convergence of apodemes IV, which is the width of capitulum behind main body suture, to a point in transverse line with outer basal extremities of coxae IV, the apodeme bifurcate at this point the arms remaining approximate to each other as they continue to inner basal angles of coxae IV. Dorsum of propodosoma projected forward somewhat to form a cephalothoracic hood which covers base of capitulum, the anterior margin of hood angularly truncate and as broad as the capitulum. *Dorsal chaetotaxy:* First pair of dorsal propodosomal setae about as long as combined lengths of genu, tibia and tarsus I, situated one fourth length of seta behind anterior margin of propodosoma and separated from each other by a distance equal to one third length of seta; second pair of setae about three fifths as long as setae of first pair, situated behind and slightly laterad from first setae a distance equal to two thirds length of second seta; third pair of setae one and two-thirds times as long as first setae, located behind and slightly laterad from second setae a distance about equal to distance separating first and second setae; fourth pair of setae about as long as second setae, located laterad from and slightly behind setae of third pair a distance equal to one third length of fourth seta. First pair of dorsal hysterosomal setae about two thirds as long as third propodosomals, located near lateral margins of body the length of seta from main body suture; second pair of setae about one half as long as first pair; third pair of setae two thirds as long as first pair; fourth pair of dorsal hysterosomal setae about three fourths as long as setae of third pair, situated near lateral margins of genital papilla at anterior fourth of papilla. *Ventral chaetotaxy:* First pair of ventral propodosomal setae as long as basal width of tarsus I, located the length of seta laterad from juncture of apodemes I; second pair of setae slightly longer than setae of first pair, situated near centers of areas delimited by apodemes II, median apodeme, transverse apodeme and bases of coxae II. First pair of ventral hysterosomal setae nearly as long as second dorsal propodosomals, located in anterior eighth of area delimited by apodemes III and IV; second ventral hysterosomals slightly shorter than setae of first pair, situated on apodemes IV at their posterior two fifths. *Capitulum:* Subcordate with posterior rounded and with a shallow emargination medially; length including projecting palpi, 28µ; greatest width, measured at posterior third, 21µ. Dorsal setae with length slightly less than greatest width of capitulum, located near anterolateral margins of capsule. Ventral setae slightly shorter than dorsal setae, located near bases of palpi and separated from each other by a distance equal to two thirds length of seta. Palpi of moderate length and thickness, projecting beyond apex of capitulum for a short distance, inconspicuously segmented and ornamented. Styliform chelicerae project between but not beyond palpi; cheliceral sheaths minutely striate. *Legs:* Anterior pairs moderately long and stout, subequal in length but legs I slightly more robust than legs II; posterior pairs moderately long and stout. Leg I with coxa subquadrangular, broader than long, without vestiture; femur as long as coxa, tapering from base toward apex, with three normal setae; genu about as broad as long, with four setae; tibia slightly longer than genu and slightly longer than broad, with one rodlike seta with length equal to two thirds basal width of segment, situated dorsally near outer margin one-half length of seta from base of segment, one clavate, annulated seta with length equal to one half basal width of segment, situated middorsally the length of seta from base of segment, one capitate sense seta as long as the rodlike seta, located between this latter seta and the clavate seta, five normal setae; tarsus slightly longer than tibia, tapered from base to narrowly rounded apex, with one broad, clavate, annulated seta having length equal to basal width of segment, situated dorsally near outer basal margin of segment, eight normal setae; tarsus surmounted by a short pretarsus bearing at its apex a strong, curved claw and a broad empodium. Leg II with coxa of the same shape as coxa I but slightly larger, without vestiture; femur slightly longer but not as broad as femur I, with three setae; tibia slightly longer than genu, with four setae; tarsus about twice as long as tibia, tapering slightly from basal third to broadly rounded apex, with one large, clavate, annulated seta having length greater than basal width of segment, situated dorsally near inner basal margin of segment, one stout, spinelike, sensory seta with length equal to one half basal width of segment, located dorsally near outer basal margin of segment, four normal setae; tarsus surmounted by a short, broad pretarsus bearing at its apex two strong, curved, spreading claws between and beyond which projects a broad, bilobed empodium. Leg III with coxa slender, elongate, as long as combined lengths of genu, tibia and tarsus I, about one third as broad as long, without vestiture; femur two thirds as long as coxa, basifemur separated from telofemur by an incomplete suture at middle of segment, one seta on telofemur; genu one half as long as broad, with three setae; tibia slightly shorter than and equally as broad as genu, with four setae; tarsus slender, elongate, one and one-half times as long as genu, tapering from base to apex, with three setae; tarsus surmounted by a short, broad pretarsus bearing at its apex two long, curved, spreading claws between and beyond which projects a broad, bilobed empodium. Leg IV with coxa large, subquadrangular, nearly one and two-thirds times as broad as long, with one seta; femur stout, elongate, about twice as long as broad at base, tapering from base toward apex with width at apex about one third width at base, one dorsal seta three fourths as long as segment located near outer margin slightly distad from mid-segment, one ventral seta nearly two thirds as long as dorsal seta, situated near inner margin at apical fourth of segment, one small ventral seta, shorter than apical width of segment, located on inner margin at basal third; tibia robust, only slightly longer than broad at base, with one rodlike, sensory seta one half as long as segment, located dorsally near outer apical margin, one short tactile seta twice as long as segment, located ventrally near outer apical margin; tarsus small, broader than long, with two short dorsal setae and one short ventral seta; tarsus surmounted by a large, curved claw as long as tibia. *Genital papilla:* Subcordate with anterior margin slightly emarginate; length excluding extended styliform aedeagus, 31μ; greatest width, measured at mid-length of papilla, 26μ. *Anal plate:* Small but conspicuous, situated the length of tibia IV in front of anterior margin of genital papilla, two strong, short apodemes projecting anterolaterally from anterolateral extremities of central disc. *Measure-*

ments: Length from tips of palpi to apex of genital papilla, 191μ; main body suture to apex of genital papilla, 113μ; anterior margin of cephalothoracic hood to main body suture, 50μ; width of body at anterior condyles of coxae III, 97μ.

Female: Body broadly oval, broadest at mid-length. Legs of moderate length and robustness; legs II only slightly larger than legs I; legs III and IV of moderate size, the latter not extending to margins of body; legs III separated from each other at nearest point by a distance slightly less than length of coxa III; inner angles of coxae IV separated from each other by a distance equal to length of coxa IV. Apodemes moderately distinct, those of legs I extending in posteromedial directions from innermost angles of coxae I and converging medially to form a Y-shaped juncture with anterior extremity of median apodeme. Apodemes II subparallel to apodemes I, extending from innermost angles of coxae II for a distance equal to the length of femur I, terminating abruptly at points the basal width of tarsus II from median apodeme. Transverse apodeme thickened and distinct, extending in a posteriorly directed arc from points the basal width of tibia II behind posterolateral extremities of coxae II to an indistinct juncture with median apodeme and curving slightly forward to juncture with the latter. Anterior median apodeme strong and distinct from its anterior extremity at juncture of apodemes I to point slightly posterior to mesal terminations of apodemes II, continuing weakly to juncture with transverse apodeme. Apodemes III extending in anteromedial directions from anterior condyles of coxae III for a distance equal to one half length of coxa III, anterior half of apodemes expanded, fan-shaped, these extremities widely separated from each other. Apodemes IV weak but conspicuous, subparallel to apodemes III, extending from points near inner margins of coxae III in line with posterior fourth of segments to juncture with median apodeme at a point in transverse alignment with anterior eighth of coxae III. Posterior median apodeme weak, seen only as a thin line extending from point of juncture of apodemes III to a point slightly behind posterior extremities of coxae IV, not continuous for its entire length. A weak but conspicuous median dorsal apodeme extends in interrupted manner from anterior third of propodosoma almost to main body suture, strongest near its posterior extremity. Five transverse sutures visible on hysterosoma, the first inconspicuous and transecting body near anterior extremities of coxae III, the second conspicuous and near mid-lengths of coxae III, the third at coxae IV and the remaining two dividing opisthosoma into three segments. Dorsum of propodosoma narrowed and projected anteriorly to form a cephalothoracic hood with its anterior margin truncate and slightly broader than capitulum, the hood projecting only over basal tenth of capitulum. Pseudostigmatic organs as long as tarsus II, with broadly oval apices twice as long as slender pedicels. Stigmatal openings distinct, situated dorsally on lateral margins of propodosoma the basal width of tibiotarsus I behind anterolateral extremities of hood. *Dorsal chaetotaxy:* First pair of dorsal propodosomal setae as long as capitulum, situated on anterolateral angles of cephalothoracic hood; second pair of setae one and one-half times as long as setae of first pair, located midway between anterolateral margins of hood and main body suture. Of the six pairs of dorsal hysterosomal setae the first pair are the longest, being slightly longer than the first propodosomals, the sixth pair are the strongest and nearly as long as the first pair, remaining pairs subequal in size. *Ventral chaetotaxy:* First pair of ventral propodosomal setae as long as basal width of tarsus II, located slightly anterior to apodemes I just before anterolateral extremities of these apodemes; second pair of setae slightly longer than setae of first pair, situated on apodemes II at their mid-lengths. First pair of ventral hysterosomal setae as long as second propodosomals, located just mesad from the broad anterior extremities of apodemes III; second ventral hysterosomal setae as long as first ventral hysterosomals, located on apodemes IV near their posterior extremities; third hysterosomals very short, situated near apex of opisthosoma. *Capitulum:* Subcordate with posterior margin deeply emarginate; length including projecting palpi, 31μ; greatest width, measured at posterior third, 23μ. Dorsal setae with length equal to one half width of capitulum, located near anterolateral margins of capsule. Ventral setae slightly shorter than dorsal setae, situated near bases of palpi. Palpi moderately long and robust, projecting beyond apex of capitulum, indistinctly segmented and ornamented. Chelicerae projecting between but not beyond palpi; cheliceral sheaths without striae. *Legs:* Anterior pairs moderately long and stout, subequal in size. Leg I with coxa subquadrangular, broader than long, without setae; femur one and one-half times as long as broad, tapered slightly toward apex, with one stout, lanceolate seta situated dorsally near outer apical margin, two normal setae; genu two thirds as long as broad at base, with three setae; tibiotarsus nearly as long as femur, tapering slightly from base to broadly rounded apex, with one clavate, annulated, sensory seta having length equal to one third basal width of segment, situated dorsally on outer margin one third length of seta from base of segment, one capitate sensory seta slightly longer than clavate seta, situated ventrally near outer margin one half length of seta from base of segment, one spinelike seta one and two thirds times as long as clavate seta, situated just mesad from captate seta, one large, clavate, annulated seta having length equal to two thirds basal width of segment, situated dorsally near outer margin at about mid-segment, seven normal setae and one long, tactile seta as long as combined lengths of tibiotarsus and pretarsus; tibiotarsus surmounted by a short, broad pretarsus bearing a broad empodium and a long, strong, curved claw. Leg II with coxa subquadrangular; broader than long, without vestiture; femur subequal in size to femur I, with three setae; genu one half as long as femur, as broad at base as long, with one stout, spinelike seta as long as segment, situated dorsally near inner margin at base of segment, two normal setae; tibia slightly longer than broad, with four setae; tarsus as long as tibia, tapering from broad base to narrowly rounded apex, with one clavate, annulated seta having length equal to basal width of segment, located middorsally near base of segment, one short, stout, spinelike seta with length equal to two thirds basal width of segment, located dorsally near outer margin at base of segment, three normal setae; tarsus surmounted by a short pretarsus bearing at its apex two long, curved, spreading claws between and beyond which projects a broad empodium. Leg III with coxa slender, elongate, more than four times as long as broad, length equal to combined lengths of femur, genu, tibia and tarsus II, without vestiture; femur one half as long as coxa, basifemur expanded, bulbous and separated from telofemur by an incomplete suture, telofemur expanding from base to apex and twice as long as basifemur, the former with one seta; tibia four fifths as long as femur, with four setae, three of which are near apex of segment the remaining seta at about mid-segment; tarsus slender, elongate, sides subparallel, segment as long as tibia, with three setae; tarsus surmounted by a short pretarsus with imbricated margins and bearing at its apex two long, curved, spreading claws between and beyond which projects a broad empodium. Leg IV with coxa small, subquadrangular, one and one half times as long as broad, without vestiture; trochanter collarlike, broader than long, without setae; third segment slender, elongate, sides subparallel, segment three fifths as long as coxa III, with one ventral seta two fifths as long as segment, located near outer margin just before base, one stout, ventral seta one fourth as long as segment, located ventrally near outer margin one half length of seta from apex; fourth segment one fourth as long as third segment, with one stout, ventral seta nearly three times as long as segment, located just distad from mid-segment, one slender terminal seta as long as leg IV. *Measurements:* Apex of palpi to tip of opisthosoma, 264μ; anterior margin of cephalothoracic shield to tip of opisthosoma, 237μ; anterior extremity of shield to main body suture, 58μ; width of body at main body suture, 106μ; width of body at anterior condyles of coxae III, 117μ; distance between anterior condyles of coxae III, 57μ.

Types: Arlington Farm, Virginia, Feb. 5, 1935, F. F. Smith, on sugarcane.

Location of types: U. S. National Museum, slides numbered 1123 and 1123-A (as indicated below).

The above descriptions of both sexes were made from specimens of the cotype series which, on U.S.N.M. slide no. 1123, included one male and six females and which were remounted from Ewing's original type slide by the present author. These types, the male specimen of which is hereby designated lectotype (slide no. 1123-A), are deposited in the U. S. National Museum. The remaining specimens of the cotype series mounted on a single slide and including three males and several females are also in the U. S. National Museum.

Males of this species resemble most closely *T. setifer* from which it may be distinguished by the second pair of dorsal hysterosomal setae being longer than the setae of the first pair, the reverse being true in *T. setifer,* the second pair of ventral hysterosomal setae being situated on apodemes IV rather than in the interapodemal area as in *T. setifer* and the dorsal setae of femora IV being longer than either of the ventral setae, these being shorter than one of the ventral setae in *T. setifer.* In addition to details in the chaetotaxy of tibiotarsus I which differentiate the females of these two species, they may be further distinguished by differences in the transverse apodeme which is uninterrupted in *T. randsi.*

Comparisons of types made in this study indicate that *T. iowensis,* which was described by Ewing from three female specimens, is identical to *T. randsi.*

Tarsonemus smithi Ewing

(Plates 9, 19 and 23)

Tarsonemus smithi Ewing, 1939, U. S. Dept. Agr. Tech. Bull., 653, p. 18.
Tarsonemus femoralis Ewing, 1939, U. S. Dept. Agr., Tech. Bull., 653, p. 38. (new synonymy).
Tarsonemus biungulatus Ewing, 1939, U. S. Dept. Agr. Tech. Bull., 653, p. 50. (new synonymy).

Male: Body elongate oval, broadest between main body suture and legs III, sides of body tapering gradually to apex of capitulum and rather abruptly to apex of genital papilla. Apodemes well-defined and conspicuous. Apodemes I as long as width of femur I, converging from inner angles coxae I to point of juncture with median apodeme. Anterior median apodeme extending caudad to point the width of tibia I before main body suture, terminating abruptly, its continuity broken for a short distance in region of convergence of apodemes II. Apodemes II extending from inner angles of coxae II in posteromedial direction, terminating abruptly just before convergence. Transverse apodeme well defined, transecting body as an uninterrupted line just anterior to main body suture. Posterior apodemes distinct, those of legs III extending from anterior coxal condyles of legs III in anteromedial directions almost two thirds the distance to main body suture at which point apodemes turn inward at ninety degree angle to juncture with apodemes IV. Apodemes IV extending anteriorly in directions nearly parallel to apodemes III making ninety degree turn just behind anterior extremities of apodemes III and connecting with posterior median apodeme. Posterior median apodeme extending from point behind main body suture a distance equal to combined lengths genu and tibia II to inner angles of coxae IV the apodeme forked at its posterior third. Interapodemal areas defined by posterior apodemes broadest posteriorly, truncate anteriorly. Cephalothoracic shield absent. *Dorsal chaetotaxy:* Propodosoma with first three pairs of setae arranged in a longitudinal row, setae of fourth pair situated laterad to setae of third pair; first pair of setae with length equal to combined lengths of femur and genu of leg I, located one third the length of seta behind and slightly medial to anterolateral angles of propodosoma, setae separated from each other by a distance equal to two thirds length of seta; second pair of setae slightly shorter than first pair, located one half length of seta behind first pair, separated from each other by distance slightly less than length of seta; third pair of setae very long, length equal to width of body at main body suture, located one half length of seta of second pair behind and slightly laterad to these setae; fourth pair of setae subequal in length to setae of first pair, located one fourth length of seta laterad to third pair of setae. Hysterosoma with first pair of setae subequal in size to second pair propodosomal setae, located on lateral margins of body midway between anterior condyles of coxae III and main body suture; second pair of setae one and one-half times as long as first pair, situated on lateral margins of body in line with anterior fourth of coxae III; third pair of dorsal hysterosomal setae slightly longer than second pair, located slightly posterior and mesad to second pair, one half the length of seta from lateral margins of body; fourth pair of setae with length equal to one half greatest width of genital papilla, located immediately beside lateral margins of papilla at its anterior third. *Ventral chaetotaxy:* Propodosoma with first pair of setae as long as genu I, located the length of seta behind anterior extremities of apodemes I; second pair of setae subequal in length to first pair, located the length of seta behind mid-lengths of apodemes II. Hysterosoma with first and second pairs of setae located in interapodemal areas defined by apodemes III and IV; first pair as long as tibia III, located one fourth the distance from apodeme III to apodeme IV, two thirds the length of seta from anterior extremities of interapodemal areas; second pair of setae slightly longer than first pair, located close to apodemes IV a distance one and one-fourth times length of seta from posterior extremities of apodemes IV. *Capitulum:* Length including palpi, 34μ, width, 27μ; cordate, with posterior margin truncate; median dorsal longitudinal apodeme extending the length of capitulum; a pair of dorsal apodemes extending from points near lateral margins at basal third in posteromedial direction, converging with median apodeme just before its posterior extremity; dorsal setae with length equal to width of tibia I, situated near apex of capitulum and separated from each other by a distance one and one-half times length of seta; palpi two-segmented, palpal setae as long as dorsal setae, located near outer apical margins of basal segments, palpi extending beyond apex of capitulum; chelicerae projecting slightly beyond apex of capitulum; cheliceral sheaths with conspicuous circular or spiral, strandlike thickenings. *Legs:* Anterior pairs of similar size and shape, elongate robust. Leg I with coxa subquadrangular about as broad as long, without vestiture; femur twice as long as broad at apex, lateral margins subparallel, with four normal setae; genu two thirds as long as femur, one and one-half times as long as broad, lateral margins subparallel, with four normal setae; tibia nearly one and one-half times as long as genu, twice as long as broad, lateral margins subparallel, with one clavate, annulated seta with length equal to two thirds width of segment, located dorsolaterally on outer margin at basal fourth, five normal setae; tarsus about equal in length to tibia, four times as long as broad at base tapering from base to broadly rounded apex, with one lanceolate, annulated seta one half as long as segment located dorsally on outer margin near base of segment, seven normal setae; tarsus surmounted by large, single, curved claw projecting beyond a broad circular empodium. Leg II with coxa subquadrangular, slightly longer than broad at base, without setae; femur slightly larger but similar in shape to femur I, with three setae; genu one half as long as femur, slightly longer than broad, sides subparallel, with three setae; tibia one and one-half times as long as genu, twice as long as broad, lateral margins subparallel, with four normal setae; tarsus about as long as tibia, three times as long as broad at base, tapering to broadly rounded apex, with one lanceolate, annulated seta with length equal to one and one-half times basal width of segment, located dorsally near outer margin at base of segment, one small, stout, pointed bristle with length about one half the basal width of segment, located on outer margin the length of bristle from base of segment, four normal setae; tarsus surmounted by a slender pretarsus, as long as basal width of tarsus, bearing at its apex two strong, spreading, curved claws between and beyond which projects a broad empodium. Legs III with coxae widely separated, their posterolateral angles projecting beyond body margins, subtriangular in shape, slightly more than one and one-half times as long as broad at apex, without vestiture; basifemur distinct, subglobose, as broad as long, without setae; femur about twice as long as broad at apex, expanded slightly toward apex, with one seta; genu one and one-half times as long as broad, lateral margins slightly divergent from base to apex, with three setae; tibia one and one-half times as long as genu, three times as long as broad, lateral margins subparallel, with four normal setae; tarsus as long as tibia, tapering from base to narrowly rounded apex, with three setae; tarsus surmounted by a narrow pretarsus bearing two strong, spreading, curved claws and a large subcircular empodium. Leg IV with coxa subquadrangular, nearly twice as broad as long, with one seta with length equal to two thirds width of segment situated ventrally near outer margin at apical third of segment; femur with length two and one-half times width of coxa, outer margin slightly convex, inner margin greatly convex on basal three fourths of segment, apical fourth narrow, with one dorsal seta one third as long as segment located near outer margin at apical third, one seta with length slightly more than one third greatest width of segment located ventrally on inner margin at basal third, one seta with length slightly greater than one third length of segment located ventrally on inner margin two thirds the length of seta from apex of segment; tibia elongate, one third as long as femur, almost three times as long as broad at base, inner margin deeply convex, one seta one half as long as segment located dorsally near outer margin at apical third, one long, tactile seta, twice as long as segment, located mid-ventrally at apical fourth of segment; tarsus small, as broad as long, slightly less than one fourth as long as tibia, with one seta one and one-half times as long as segment located dorsally near inner margin at apical third of segment, one minute bristle one half as long as segment located dorsally near outer margin at apex, one ventral seta as long as segment situated near inner margin at apical third; tarsus terminating in a strong, broad, curved claw one-half as long as tibia. *Genital papilla:* Length, 29μ, width, 30μ; subcordate, anterior margin deeply emarginate, posterior margin rounded truncate, projecting beyond tip of opisthosoma.

Measurements: Length from tip of capitulum to apex of genital papilla, 180μ; main body suture to apex of genital papilla, 105μ; width at main body suture, 79μ; width of body at coxae III, 90μ.

Female: Body broadly oval, broadest at mid-length. Anterior apodemes distinct, those of legs I as long as width of genu II, converging on median apodeme which extends posteriorly as a faint line nearly to main body suture. Apodemes II as long as tarsus II, extending in posteromedial directions from inner angles of coxae II to points a distance equal to basal width of tarsus II laterad from median apodeme. Transverse apodeme distinct for its complete length, extending nearly to margins of body. Posterior apodemes distinct, those of legs III about one half as long as coxae III, extending from anterior coxal condyles of legs III in anteromedial directions, terminating at points one half the distance from coxal condyles to posterior median apodeme. Apodemes IV extending from point of juncture with median apodeme in line with anterior extremities of coxae III in directions toward inner apices of coxae III terminating at two thirds this distance. Anterior extremity of posterior median apodeme located one half length of coxa III behind main body suture, the apodeme extending caudad to point in line with posterior extremities of apodemes III. Hysterosoma transected by six sutures dividing this portion of body into seven segments;

segment defined by main body suture and first hysterosomal suture more than one third total length of hysterosoma. Cephalothoracic shield broadly rounded anteriorly, covering basal half of capitulum. Pseudostigmatic organs short, entire length including pedicel equal to length of tibia II, expanded apex broad, oval, about one and one-half times as long as greatest breadth, pedicel narrow, two thirds as long as apex, basal areolus with two clearly defined semicircular sclerotized areas separated by a median cleft. Stigmatal openings distinct, situated dorsolaterally between pseudostigmatic organs and anterior margin of cephalothoracic shield, the small circular openings situated on elevated tubercles; tracheae distinct as narrow tubes extending from stigmatal openings to vicinity of coxae IV, without bilobed expansions or atrial pouches. *Dorsal chaetotaxy:* Propodosoma with first pair of dorsal setae as long as width of capitulum, situated near anterolateral margins of cephalothoracic shield between stigmata and apex of shield; second pair of setae with length equal to half width of body at main body suture, located slightly more than half distance from stigmata to main body suture, about one third length of seta from lateral margins of body. Hysterosoma with first pair of setae about as long as tibiotarsus I, located on lateral margins of body two thirds the length of seta behind main body suture; setae of second pair slightly shorter than first pair, located one and one-half times length of seta from lateral body margins, about the length of seta anterior to first hysterosomal suture, this position being in front of and slightly laterad to anterior condyles of coxae III; third pair of setae with length subequal to second pair, located about twice length of seta from lateral margins of body between third and fourth hysterosomal sutures; fourth and fifth pairs of setae of about equal length, as long as third pair, located on penultimate segment of hysterosoma, outermost pair situated on lateral margins of body just behind fifth hysterosomal suture, inner pair located midway between fifth and sixth sutures the length of seta laterad from middorsum; sixth pair of setae as long as fifth pair, located on lateral margins of body near base of apical hysterosomal segment. *Ventral chaetotaxy:* First pair of setae minute, length equal to basal width of tarsus II, located the length of seta behind middles of apodemes I; second pair of setae as long as tarsus II, located on posterior margins of apodemes II at their mid-lengths. Hysterosoma with first pair of setae as long as apical segment of leg IV, located a distance two thirds the length of seta behind main body suture and the length of seta laterad from mid-body; second pair of setae slightly shorter than first pair, situated at caudal extremities of apodemes III; third pair of ventral hysterosomal setae as long as basal width of tibia III, located at tip of abdomen and separated from each other by a distance equal to one and one-half times length of seta. *Capitulum:* Length including palpi, 35μ; width, 26μ; caudal margin rounded, truncate; dorsal setae with length equal to basal width of tibiotarsus I, located just behind apex of capitulum, separated from each other by a distance equal to one and one-half times length of seta; palpi two-segmented, projecting beyond apex of capitulum; ventral setae as long as dorsal setae; chelicerae projecting slightly beyond apex of capitulum; cheliceral sheaths with transverse striations as in the male. *Legs:* Anterior pairs elongate, robust. Leg I with coxa subtriangular, broader than long, without setae; femur three times as long as broad at apex, tapering from base to apex, outer margin strongly convex at basal third, a ridgelike expansion extending along ventral surface from inner margin at apical fourth diagonally across segment to outer basal angle, with three normal setae; genu one and one-half times as long as broad, with three setae; tibiotarsus twice as long as genu, tapering from base to apex, with one long, tactile seta one and one-third times as long as segment located dorsally on outer margin one half length of seta from base, one elongate, lanceolate, annulated seta with length equal to basal width of segment located dorsally near outer margin at mid-segment, one seta one third as long as segment located dorsally near inner margin at basal fourth of segment, one seta two thirds as long as segment located middorsally at apical third, one seta two thirds length of segment located middorsally at apex, one seta as long as basal width of segment located ventrally near outer margin half length of seta from base, one seta one half as long as segment situated ventrally near inner margin at basal third, one seta one third as long as segment located on inner margin at basal third, one seta one third as long as segment located near inner margin at apical third, one broad seta nearly one half length of segment located ventrally near outer margin at apex of segment; tarsus surmounted by a short pretarsus bearing a small empodium beyond which projects a strong, curved claw. Leg II with coxa subquadrangular as broad as long, without vestiture; femur short, slightly longer than broad, with three normal setae; genu slightly longer than broad, with one strong, lanceolate seta, as long as segment, located dorsally near inner margin at base of segment, two normal setae; tibia one and one-half times as long as broad, with four normal setae; tarsus nearly one and one-half times as long as tibia, tapering from base to apex, with one mid-dorsal peglike seta having length equal to one half basal width of segment, located at base of segment, one clavate, annulated seta as long as basal width of segment, located dorsally near inner margin at base, four normal setae; tarsus surmounted by a narrow pretarsus supporting two strong, spreading, curved claws between and beyond which projects a broad empodium. Leg III with coxa narrow, elongate, nearly four times as long as its greatest breadth, inner and outer margins convex, segment as long as combined lengths of genu and tibiotarsus I, anterior condyle situated midway between apex of segment and main body suture, without vestiture; femur about two thirds as long as coxa, basal fourth bulbous, lateral margins divergent from basal fourth to apex, segment with three setae; tibia slightly longer than femur, nearly two thirds as long as coxa, tapering slightly from base to apex, segment with four setae; tarsus narrow, elongate, three-fourths as long as tibia, lateral margins subparallel, segment with three setae; tarsus terminating in a narrow pretarsus having length nearly equal to twice width of tarsus and bearing at its apex two strong, spreading, curved claws between which projects a broad empodium. Leg IV with coxa small subquadrangular, slightly longer than broad, without setae; trochanter small, collarlike, as broad as long, without vestiture; third segment narrow, elongate, its length equal to transverse distance between anterior coxal condyle of leg III and median apodeme, with one ventral seta one-fourth as long as segment, located the width of segment from base, one stout seta one-half as long as segment located ventrally one fourth length of seta behind apex; fourth segment about one third as long as third segment, with one stout, ventral seta twice as long as segment, located the width of segment before apex, one seta longer than leg IV located at apex of segment. *Measurements:* Apex of cephalothoracic shield to tip of opisthosoma, 175μ; tip of shield to main body suture, 49μ; width at main body suture, 84μ; width of body at anterior coxal condyles of legs III, 95μ; distance between anterior coxal condyles of legs III, 52μ.

Types: Rosslyn, Virginia, Oct. 31, 1933, F. F. Smith, black raspberry.

Location of types: United States National Museum No. 1118.

The type slide, U.S.N.M. number 1118, contains ten mite specimens all of which are in poor condition. This series has been identified by the present author as follows: One male *T. randsi*, one male

T. smithi, five female *T. confusus,* one *T. smithi* female in fairly good condition, one unidentifiable female in very poor condition and one female "pupa." From this series the male *T. smithi,* recognizable by its dilated hind femora, is hereby designated lectotype.

Material examined by the present writer in addition to the type series included specimens with the following data: De Faures, Puyallup, Wash., Oct. 15, 1934, Wm. W. Baker, chrysanthemum; De Faures, Puyallup, Wash., Oct. 11, 1934, Wm. W. Baker, *Ribes sanguineum;* De Faures, Puyallup, Wash., Oct. 13, 1934, Wm. W. Baker, *Althaea rosea;* Lawrence, Kansas, Aug. 1, 1949, R. E. Beer, *Rosa* sp.

The males of this species are rather easily distinguished by the expanded basal portion of femur IV and the females by the nature of the ventral apodemes and the specialized seta of genu II in addition to details of chaetotaxy of tibiotarsus I. In general appearance it most closely resembles *T. setifer.*

As indicated by Ewing (1939), who first pointed out the possibility of synonymy, this species has as a synonym *T. femoralis* which was described by the above author from a single male specimen. The holotype of *T. femoralis* was compared with the type of *T. smithi* by the present writer, who is in agreement with Ewing's suggested synonymy. Studies have also led the present author to conclude that *T. biungulatus,* which was described by Ewing from a single female specimen and which had the striking characteristic of two claws on tibiotarsus I, is in reality a synonym of *T. smithi.* The type specimen of *T. biungulatus,* because of the position of the mite on the slide, appears on casual examination to have two claws on leg I. Careful study, however, revealed this not to be the case and further that it resembles in all characteristics the type female of *T. smithi.*

Tarsonemus dispar, new species

(Plates 8, 19 and 23)

Male: Body oval, tapering abruptly from main body suture to capitulum and more gently from suture to genital papilla; broadest at main body suture; legs moderately long and stout; apodemes clear and well defined; capitulum smaller than genital papilla. Apodemes I as long as basal width of tarsus I, extending in posteromedial directions from inner condyles of coxae I converging medially at anterior extremity of median apodeme. Apodemes II subparallel to apodemes I and four times as long as the latter, extending from inner anterior condyles of coxae II to juncture with median apodeme. Transverse apodeme strong and distinct, extending in smooth arc connecting posterior condyles of coxae II. Anterior median apodeme strongest between apodemes I and II but distinct for its entire length, extending from point of convergence of apodemes I to point of intersection with transverse apodeme just anterior to main body suture. Apodemes III strong and broad, extending in a smooth arc from anterior condyles of coxae III to points of intersection with apodemes IV slightly behind main body suture. Apodemes IV not as broad as apodemes III but clearly defined for their entire lengths, extending in anteromedial directions from anterolateral condyles of coxae IV to point of intersection with apodemes III, the width of tarsus I from midline, recurved at this point forming scalloped anterior margin for the interapodemal areas delimited by apodemes IV and the median apodeme. Posterior median apodeme extending from Y-shaped juncture of apodemes IV slightly behind main body suture to a point in line with anterolateral condyles of coxae IV, distinct for its entire length. A strong hysterosomal suture transects body at anterior extremities of coxae IV, distinct both dorsally and ventrally. Propodosomal shield narrowly and angularly truncate at its anterior extremity, projecting to cover basal sixth of capitulum dorsally. *Dorsal chaetotaxy:* First pair of dorsal propodosomal setae stout, slightly longer than capitulum with its projecting palpi, situated just behind anterolateral extremities of propodosoma; second pair of setae about one-third as long as setae of first pair, situated twice length of seta behind and slightly laterad from first setae; third pair of setae slightly longer than greatest width of body, located one and one-half times length of second seta behind and slightly laterad from second setae; fourth pair of setae slightly longer than setae of second pair, nearly in linear arrangement with others, located one half length of seta behind and laterad from third setae. First pair of dorsal hysterosomal setae subequal in size to first propodosomals, located near margins of body two thirds length of seta behind main body suture; second, third and fourth pairs of setae subequal in size, about one half as long as first hysterosomals, third and fourth pairs located very close to genital papilla. *Ventral chaetotaxy:* First pair of ventral propodosomal setae small, about one half as long as second dorsal propodosomals, located the length of seta laterad from Y-shaped juncture of apodemes I; second propodosomals twice as long as setae of first pair, located two thirds length of seta behind apodemes II at their mid-lengths. First pair of ventral hysterosomal setae as long as second propodosomals, located on inner margins of apodemes III the length of seta before intersection of apodemes III and IV; second hysterosomal setae slightly longer than first ventral hysterosomals, located on apodemes IV twice length of seta before posterior extremity of apodeme. *Capitulum:* Small, subcordate, posterior margin rounded truncate; length including projecting palpi, 26μ; greatest width, 19μ. Dorsal setae with length slightly greater than half width of capitulum, located near anterolateral margins of cephalic capsule and separated from each other by a distance equal to length of seta. Ventral setae one half as long as dorsal setae and slightly more approximate to one another. Palpi short and slender, projecting a short distance beyond apex of capitulum, indistinctly segmented and ornamented. Chelicerae short, styliform, projecting slightly beyond tips of palpi, cheliceral sheaths without striae. *Legs:* Anterior pairs subequal in size, moderately long and stout, legs III more slender, legs IV of moderate size. Leg I with coxa subquadrangular, nearly twice as broad as long, without vestiture; femur short and stout, nearly as broad as long, with three short and one long setae; genu broader than long, with four setae; tibia as broad as long, length equal to length of genu, with one peglike sensory seta nearly as long as segment, located dorsally on outer margin at basal third of segment, one capitate sensory seta two thirds as long as peglike seta, situated dorsally beside the latter, one short clavate, annulated seta as long as capitate seta, located dorsally slightly mesad to the capitate seta, four normal setae and one long tactile seta; tarsus twice as long as tibia, tapering from base to broadly rounded apex, with one short, clavate, annulated sensory seta having a length equal to one half basal width of segment, located dorsally near outer margin the length of seta from base of segment, seven normal setae; tarsus surmounted by a short, broad pretarsus bearing at its apex a strong, curved claw and a broad empodium. Leg II with coxa large and subquadrangular, nearly twice as broad as long, without setae; femur two thirds as broad as long, slightly larger than femur I, with two setae; genu as broad as long, with three setae; tibia as long as genu, tapering slightly from base toward apex, with four setae; tarsus slightly longer than tibia, tapering from base to broadly rounded apex, with one clavate, annulated, sensory seta as long as basal width of segment, located dorsally near inner margin one half length of seta from base of segment, one lanceolate seta as long as clavate seta, situated dorsally near outer margin one half length of seta from base of segment, one strong, spurlike projection extending from outer ventral margin of segment just before apex, four normal setae on segment; tarsus surmounted by a short pretarsus bearing at its apex two large, curved, spreading claws between and beyond which projects a broad, bilobed empodium. Leg III with coxa broadly elongate, about three fifths as broad as long, length equal to combined lengths of femur and genu II, without vestiture; femur moderately long and stout, four fifths as long as coxa, about one half as broad as long, with one ventral seta; genu short, as broad as long, with three setae; tibia nearly twice as long as genu and twice as long as broad, with one clavate, annulated, sensory seta as long as width of segment, located dorsally at apical fifth of segment, three normal setae; tarsus as long as tibia, tapering from base to narrowly rounded apex, with three setae; tarsus surmounted by a short pretarsus bearing apically a pair of strong, curved, spreading claws between and beyond which projects a broad, bilobed empodium. Leg IV with coxa subtriangular, about as broad as long, with one ventral seta near outer margin, its length about one half length of segment; femur about twice as long as coxa, outer margin convex, inner margin with flangelike projection curving in smooth, slightly convex arc from mid-segment to apex, segment with one short dorsal seta having a length about equal to one fourth length of segment, situated near outer margin the length of seta before apex, one short ventral seta two thirds as long as dorsal seta, located near inner margin at mid-segment, one long ventral seta, one third as long as segment, located near inner margin the length of dorsal seta before apex of segment; tibia of moderate length, about one and one-half times as long as broad, with one peglike, annulated, sensory seta nearly as long as width of segment, located dorsally near outer margin at apical third of segment, one long tactile seta nearly as long as femur, located ventrally near inner margin at apex; tarsus slightly broader than long, with one dorsal seta twice as long as segment located near inner margin, one dorsal seta as long as segment, situated at mid-segment near apex, one ventral seta as long as segment, located near inner margin at basal third of segment; tarsus surmounted by a strong, curved claw, twice as long as tarsal segment. *Genital papilla:* Large and well-defined, subcordate with anterior margin rounded truncate and possessing a moderate medial emargination; posterolateral extremities extended as conspicuous, laterally projecting horns; papilla somewhat larger than capitulum. Length including projecting appendages, 26μ; greatest width, 23μ. *Anal plate:* Situated ventrally immediately anterior to forward margin of genital papilla, its central disc ovate and with two short apodemes projecting from anterolateral extremities of disc. *Measurements:* Length of body from tips of projecting palpi to hind extremity of genital papilla, 158μ; width of body immediately behind main body suture, 94μ; anterior margin of propodosoma to main body suture, 50μ.

Female: Body moderately elongate, oval, broadest immediately behind main body suture. Legs moderately long and of medium robustness, the anterior pairs widely separated from posterior pairs, coxae IV separated from each other by a distance equal to length of coxa IV. Apodemes distinct and clearly defined, those of legs I quite short, extending from innermost angles of coxae I in posteromedial directions, converging medially at anterior extremity of median apodeme. Apodemes II subparallel to apodemes I becoming indistinct some distance from median apodeme. Anterior median apodeme strongest between anterior extremity and point in line with medial extremities of apodemes II, indicated only faintly posterior to this point. Transverse apodeme absent. Apodemes III strongest near coxae III, extending in anteromedial directions from anterior condyles of coxae III in sweeping arcs recurved just behind main body suture and intersecting each other medially at anterior extremity of median apodeme, this point being the length of tarsus II behind main body suture. Apodemes IV extending in anteromedial directions from points just mesad to inner margins of coxae III at their posterior two fifths to intersection with median apodeme at its anterior third. Posterior median apodeme distinct from point of convergence of apodemes III to point in line with anterior extremities of coxae IV. Hysterosoma transected dorsally by three distinct sutures. Dorsum of propodosoma extended forward beyond stigmatal openings to form a broadly rounded cephalothoracic hood, separated from remainder of propodosoma by a weak suture, which covers almost the entire capitulum. Stigmatal openings conspicuous, situated dorsolaterally in depressions of lateral margins one third the distance from anterior extremity of cephalothoracic to main body suture. Pseudostigmatic organs spinelike, without expanded apices, length equal to length of genu II. *Dorsal chaetotaxy:* Propodosoma with first pair of setae having length equal to length of genu I, located near lateral margins of cephalothoracic hood at about its mid-length; second pair of propodosomal setae quite long, located the length of genu I before main body suture nearly twice this distance from lateral margins of body. Hysterosoma with six pairs of short setae, the first pair located laterally near main body suture, second and third pairs situated near posterior margins of first and second hysterosomal segments respectively, fourth and fifth pairs located near posterior margin of third segment, sixth pair situated near posterior margin of fourth hysterosomal segment. *Ventral chaetotaxy:* Propodosoma with first pair of setae having length equal to two thirds basal width of tibiotarsus I, located one half length of seta laterad from Y-shaped juncture of apodemes I and median apodeme; setae of second pair slightly longer than first setae, located the length of latter behind apodemes II near mid-lengths of apodemes. First pair of ventral hysterosomal setae as long as second propodosomals, located on apodemes III near most anterior extension of the apodemal arcs, these points being the length of seta behind main body suture; second pair of setae as long as setae of first pair, located on apodemes IV near posterior extremities of apodemes; third pair of setae slightly longer than setae of second pair, located at apex of hysterosoma and separated from each other by their combined lengths. *Capitulum:* Subcordate, with posterior margin deeply and angularly emarginate; length including projecting palpi, 34μ; greatest width, 26μ. Dorsal setae with length equal to one half width of capitulum, located near lateral margins at apical third of capsule. Ventral setae as long as dorsal setae and slightly more approximate to each other, located at about apical third of capitulum. Palpi narrow, elongate, indistinctly segmented and ornamented. Chelicerae short, styliform, not projecting beyond palpi; cheliceral sheaths not striate. *Legs:* Anterior pairs stout and of moderate length, subequal in size. Leg I with coxa subquadrangular, slightly broader than long, without vestiture; femur one and one half times as long as broad, with two short setae and one long ventral seta; genu slightly longer than broad, about two thirds as long as femur, with four setae; tibiotarsus slightly longer than femur, three times as long as broad at base, tapering from base to broadly rounded apex, with one clavate, annulated, sensory seta having a length nearly equal to one half basal width of segment, located dorsally on outer margin the length of seta from base of segment, one capitate, sensory seta nearly as long as clavate seta, situated ventrally beside the latter, one rodlike sensory seta as long as capitate seta, situated ventrally beside the latter, one large, clavate, annulated, sensory seta with length nearly equal to basal width of segment, located dorsally near outer margin at basal two fifths of segment, one short, spurlike process projecting from inner apical angle of segment, ten normal setae on segment; tarsus surmounted by a short pretarsus bearing at its apex a large, broad empodium and a strong, curved claw. Leg II with coxa subquadrangular, about as broad as long, without vestiture; femur short and stout, as broad as long, with three setae; genu broader than long, with three setae; tibia slightly longer than broad, with four normal setae; tarsus slightly longer than tibia, tapered from base to narrowly rounded apex, with one clavate, annulated seta having length equal to basal width of segment, located dorsally near outer margin at base of segment, one short, broadly conical seta with length equal to two thirds basal width of segment located on outer margin at about mid-segment, one short, stout, spurlike projection on inner apical angle of segment, four normal setae; tarsus surmounted by a short pretarsus which bears at its apex two large, curved, spreading claws between and beyond which projects a large, broad empodium. Leg III with coxa slender, elongate, its length slightly greater than combined lengths of femur, genu and tibia II, greatest width about one fourth length of segment, without vestiture; femur about one half as long as coxa, constriction with incomplete suture at basal third of segment, one short ventral seta near outer margin just distad from constriction, two ventral setae at apical fifth of segment; tibia slender, elongate, sides subparallel, one and one-fourth times as long as femur, three times as long as broad, segment with three setae; tarsus about three fifths as long as tibia, tapering slightly to broadly rounded apex, with a short spurlike projection on outer ventral margin at apex and four normal setae; tarsus surmounted by a short pretarsus bearing two strong, curved, spreading claws between and beyond which projects a broad empodium. Leg IV with coxa subtriangular, as long as telofemur III, nearly as broad as long, without vestiture; trochanter broader than long, length equal to one half length of coxa, without vestiture; third segment slender, elongate, slightly bowed, about five times as long as broad at base, nearly as broad at apex as at base, with one ventral seta one fourth as long as segment, located near outer margin just before base of segment; fourth segment slightly less than one half as long as third segment, with one stout ventral seta about twice as long as segment, located near outer margin at about mid-length of segment, one terminal seta very broad at base and one and one fifth times as long as leg IV. *Measurements:* Apex of cephalothoracic shield to tip of opisthosoma, 200μ; tip of shield to main body suture, 57μ; width of body at main body suture, 96μ; width of body at anterior condyles of coxae III, 108μ.

Holotype: Male, near Baldwin, Kansas, Feb. 2, 1953, C. C. Hall, from *Popilius disjunctus* (Ill.).

Allotype: Female, same data as holotype.

Paratypes: One male and nine females, same data as holotype. Two males and four females, Lewrence, Kansas, Feb. 18, 1953, R. E. Beer, from *Popilius disjunctus* (Ill.)

Location of types: Holotype, allotype, one male and nine female paratypes in Snow Entomological Museum, University of Kansas. Two males and four females at U. S. National Museum.

This species is unique in having the pseudostigmatic organs of the female greatly reduced, a degree of specialization no doubt well suited for their peculiar habitats. Also the large cephalothoracic hood which covers most of the capitulum serves in distinguishing this sex from closely related forms. The males are easily distinguished from other species in the genus on the basis of characters of leg IV, the presence of a specialized sensory seta on tibia III and other less conspicuous details. The species seems to bear the closest resemblance to *T. laminifer*, *T. sulcatus* and *T. setifer*, and for this reason is placed in the Setifer Group.

Specimens have been collected thus far only from one habitat, namely, beneath the elytra of the passalid beetle, *Popilius disjunctus* (Ill.). Here they are found most abundantly in a small dorsal pocket of the elytron's anterolateral extremity. However, a few specimens were found walking about on both surfaces of the folded hind wings and on other inner surfaces of the elytra.

Tarsonemus sulcatus, new species

(Plates 10, 19 and 23)

Male: Body oval, broadest at mid-length; legs moderately long and stout; apodemes strong and well defined. Genital papilla somewhat smaller than capitulum. Apodemes I as long as genu I, extending in posteromedial directions from innermost angles of coxae I, converging medially to form a distinct Y-shaped juncture with anterior median apodeme. Apodemes II subparallel to apodemes I, extending from anterior basal condyles of coxae II to juncture with median apodeme. Anterior median apodeme distinct for its entire length, extending from juncture of apodemes I almost to main body suture. Transverse apodeme absent. Apodemes III strong and conspicuous, extending from anterior condyles of coxae III to a position the length of genu I behind main body suture, angularly recurved at this point and continuing to juncture with apodemes IV. Apodemes IV conspicuous, linear, appearing as straight anteromesally directed lines, extending to positions slightly exceeding the length of genu I behind main body suture, curving in smooth arcs at this point and intersecting median apodeme at a point the length of tibia I behind main body suture. Posterior median apodeme conspicuous for its entire length, extending from juncture of apodemes IV to a point in line with mid-coxae III, bifurcate at this point and extending to suture which transects body at anterior extremities of coxae IV. Dorsum of propodosoma with anterior margin broadly truncate and projecting to form a hood which covers basal third of capitulum. *Dorsal chaetotaxy:* Propodosoma with four pairs of setae, the first three pairs in longitudinal linear arrangement. Setae of first pair about as long as combined lengths of femur and genu I, not widely separated being one-third length of seta from each other; second pair of setae about equal in size to setae of first pair, located about two thirds length of seta posterior to and slightly laterad from first setae; third pair of setae elongate, three times as long as second setae, situated about one half length of second seta behind and slightly laterad from these setae; fourth pair of setae about equal in size to setae of second pair, situated one third length of seta laterad from setae of third pair. First pair of dorsal hysterosomal seta slightly longer than first propodosomals, situated near body margins one half length of seta behind main body suture; second and third pairs of setae quite long, about twice as long as first propodosomals; fourth pair of dorsal hysterosomal setae short, about one half as long as first propodosomals, situated near anterolateral extremities of genital papilla and separated from each other by a distance equal to one and one-half times length of seta. *Ventral chaetotaxy:* First pair of setae on propodosoma with length equal to length of genu I, located one half length of seta behind and laterad from Y-shaped juncture of apodemes I and median apodeme; setae of second pair slightly longer than first setae, situated near centers of area delimited by apodemes II, median apodeme, main body suture and inner margins of coxae II. First pair of ventral hysterosomal setae as long as second propodosomals, located the length of seta behind anterolateral angles of apodemes III; second pair of setae slightly longer than setae of first pair situated in transverse line with anterior condyles of coxae III, two thirds the distance from these condyles to apodemes IV. *Capitulum:* Subcordate with posterior margin rounded truncate and possessing a slight identation mesally; length including projecting palpi, 32μ; greatest width, 29μ. Dorsal setae relatively short, length less than one half width of capitulum, located on anterolateral margins of capsule in line with basal third of palpus. Ventral setae slightly shorter than dorsal setae and slightly more approximate, situated in transverse line with dorsal setae. Palpi stout, of moderate length, indistinctly segmented and ornamented, projecting beyond apex of capsule. Chelicerae of moderate length, styliform, projecting between palpi and extending to apices of the latter; cheliceral sheaths with transverse striae. *Legs:* Anterior pairs moderately long and stout, legs I slightly longer than legs II; posterior pairs of moderate size. Leg I with coxa subquadrangular, broader than long, without vestiture; femur robust, about two thirds as broad as long, tapered slightly from base toward apex, with four setae; genu about as broad as long, one half as long as femur, with four setae; tibia one and one-fourth times as long as genu, slightly less than one and one-half times as long as broad, with one clavate, annulated seta having length equal to three fourths basal width of segment, located ventrally near outer margin just before base of segment, one short, clavate, annulated seta, one half as long as the former, situated dorsally near outer margin near base of segment, four normal setae; tarsus slightly longer than tibia, tapering from base to broadly rounded apex, with one long, lanceolate seta about one half as long as segment, located dorsally near outer margin at base of segment, eight normal setae; tarsus surmounted by a short pretarsus bearing a small empodium and a small, curved claw. Leg II with coxa subquadrangular, slightly broader than long, without vestiture; femur as broad as long, about two thirds as long as femur I, with four setae; genu slightly broader than long, with three setae; tibia one and one-fourth times as long as genu, with four setae; tarsus one and one-third times as long as tibia, tapering from broad base to narrowly rounded apex, with one lanceolate seta nearly as long as basal width of segment, located dorsally near inner margin at base of segment, one very short, broad, spinelike seta having length equal to one fourth basal width of segment, located dorsally near outer margin the length of seta from base of segment; tarsus surmounted by a moderately long, slender pretarsus bearing at its apex two curved, spreading claws between and beyond which projects a broad, bilobed empodium. Leg III with coxa broad and elongate, sides diverging from anterior condyles to apical third of segment, length equal to twice greatest breadth of segment, without vestiture; femur three fifths as long as coxa, about twice as long as broad, segment bent outward at nearly a right angle near mid-length, with one seta; genu short, as broad as long, with three setae; tibia one and one-half times as long as genu, with four setae; tarsus slightly longer than tibia tapering from base to narrowly rounded apex, with three setae; tarsus surmounted by a slender pretarsus about one third as long as tarsus and bearing at its tip two spreading, curved claws of moderate size between and beyond which projects a broad, bilobed empodium. Leg IV with coxa subquadrangular, size subequal to coxa I, about two thirds as long as broad, with one ventral seta; femur nearly as long as combined lengths of genu, tibia and tarsus III, about two fifths as broad at base as long, outer margin slightly and evenly convex, inner margin greatly convex for basal two thirds of segment, straight at apical third, greatest width of segment at basal third at this point being one half as broad as long, segment with one dorsal seta having length slightly greater than basal width of segment, situated one third distance from outer to inner margin at about apical third of segment, one ventral seta as long as dorsal seta situated near inner margin at apical third, this point being at point of termination of dilated portion of segment, another ventral seta one-half as long as the former, located on inner margin at about basal fifth of segment; tibia moderately long and slender, about twice as long as broad at base, length equal to basal width of femur, with one dorsal, rodlike seta with length equal to width of segment, situated near outer margin at apical fourth, one long tactile seta, more than three times as long as segment and slightly longer than femur, situated near apex of segment; tarsus small, about one and one-half times as broad as long, with three short setae, one ventral, the other two dorsal; tarsus surmounted by a strong, curved claw, its length nearly equal to length of tibia. *Genital papilla:* Subcordate with anterior margin having a broad median emargination, posterior margin broadly rounded; length including projecting appendages, 24μ; greatest width measured at anterior fifth, 23μ. *Measurements:* Length of body from tips of palpi to apex of genital papilla, 160μ; greatest width, 99μ; anterior margin of cephalothoracic hood to main body suture, 42μ; main body suture to apex of genital papilla, 97μ; width of body at main body suture, 78μ; width at anterior apodemes of coxae III, 87μ.

Female: Body broadly and regularly oval, broadest at midlength. Legs relatively short and stout, the anterior pairs widely separated from posterior pairs; legs III separated from each other by a distance equal to distance from posterolateral margins of coxae III to margins of body; inner margins of coxae IV separated by a distance equal to one and one-half times length of coxa IV. Apodemes indistinct, weak, not clearly defined, those of legs I as long as genu I, extending in posteromedial directions from innermost angles of coxae I converging medially to form Y-shaped juncture with median apodeme. Apodemes II subparallel to apodemes I for most of their lengths, curving gently in caudad directions just before intersecting median apodeme and losing definity shortly beyond these points. Transverse apodeme present but weak, extending in smooth, uninterrupted arc just anterior to main body suture, its lateral extremities indistinct but not contacting coxae II. Anterior median apodeme weak but continuous, extending from point of convergence of apodemes I almost to transverse apodeme. Posterior apodemes weak, those of legs III extending indistinctly in anteromedial directions from anterior condyles of coxae III, curving inward just behind main body suture and disappearing at points two thirds length of genu I behind this suture. Apodemes IV extending in anteromedial directions from outer anterior condyles of coxae IV directed toward intersecting median apodeme at its mid-length but becoming indistinct before juncture. Posterior median apodeme weak, extending from point in transverse line with anterior extremities of coxae IV to point the length of genu I behind main body suture, becoming bifurcate here, each arm of apodeme extending in anterolateral direction and disappearing after a short distance. Segmentation of hysterosoma pronounced, the first suture transecting body at about anterior third of coxae III, second suture at coxae IV, two sutures divide opisthosoma into three segments. Dorsum of propodosoma projected to form hood with a broadly rounded anterior margin, this hood covering posterior half of capitulum. Pseudostigmatic organs with length slightly greater than length of genu I, their pedicels about one third as long as the broadly oval apices, circular areoli with diameters equal to three fourths greatest width of expanded apices. Stigmatal openings not distinct, situated near anterolateral extremities of cephalothoracic hood. *Dorsal chaetotaxy:* First pair of propodosomal setae as long as tibiotarsus I, located one half length of seta behind anterior margin of propodosoma and separated from each other by a distance equal to length of seta; setae of second pair about as long as leg II situated the length of genu I in front of main body suture and separated from each other by a distance slightly less than length of seta. First pair of dorsal hysterosomal setae as long as tibiotarsus, setae of second pair slightly shorter, the remaining four pairs less than one half as long as second seta. *Ventral chaetotaxy:* First pair of ventral propodosomal setae small, length equal to basal width of tibiotarsus I, located the length of seta in posterolateral direction from juncture of apodemes I; setae of second pair about one and one-half times as long as first setae, situated near centers of areas delimited by apodemes II, median apodeme, transverse apodeme and inner bases of coxae II. First pair of hysterosomal setae as long as second propodosomals located at points the length of seta behind main body suture, separated from each other by a distance equal to five times length of seta; second ventral hysterosomal setae subequal in size to setae of first pair, located on apodemes IV one and one-half times length of seta anterior to the subacute anterior extremities of coxae IV; third pair of setae small, located near apex of opisthosoma. *Capitulum:* Subcordate with posterior margin rounded truncate and possessing a shallow, medial emargination; length including projecting palpi, 30μ; greatest width, measured at basal fourth of capsule, 29μ. Dorsal setae with length equal to two fifths greatest width of capitulum, situated near lateral margins at apical third. Ventral setae slightly shorter than dorsal setae, situated a bit more approximate to each other than are the dorsal setae and in transverse alignment with the latter. Palpi short, broad, indistinctly segmented and adorned, projecting a short distance beyond apex of capitulum. Chelicerae short, needlelike, not projecting beyond palpi; cheliceral sheaths without striae. *Legs:* Anterior pairs relatively short and stout. Leg I with coxa subquadrangular, broader than long, without vestiture; femur as broad as long, with four normal setae; genu as broad as long, with four setae; tibiotarsus three times as long as broad at base, tapering slightly to broadly rounded apex, with one long, rodlike, sensory seta having length nearly equal to one half basal width of segment, located ventrally one third length of seta from outer margin, this distance from base of segment, one clavate, annulated, sensory seta about one third as long as rodlike seta situated beside the latter, one clavate, annulated seta one half as long as rodlike seta, located beside the smaller clavate seta nearly on lateral margin of segment, one large, clavate, annulated seta with length nearly equal to one half basal width of segment located on lateral margin just proximad to mid-segment, one clavate, annulated seta with length about equal to one fourth basal width of segment, situated dorsally near outer margin at apical third, one short, spinelike seta, its length equal to one fourth basal width of segment, located ventrally near outer margin at apex, one tactile seta longer than segment located dorsally near outer margin at basal sixth, nine normal setae; tarsus surmounted by a short, stout pretarsus bearing at its apex a strong curved claw and a small empodium. Leg II with coxa subequal in size to coxa I, without vestiture; femur similar in size and shape to femur I, with three setae; genu broader than long, with one stout, spinelike seta as long as segment, located ventrally near inner margin at base, two normal setae; tibia as broad as long, with four setae; tarsus as long as tibia, tapering from broad base to narrowly rounded apex, with one clavate, annulated sensory seta nearly as long as basal width of segment, located on inner margin at base of segment, one short, pronounced spurlike projection located ventrally near outer margin at apex, four normal setae; tarsus surmounted by a short, broad pretarsus bearing at its apex two strong, curved, spreading claws between which projects a broad empodium. Leg III with coxa elongate oval, slightly longer than tibiotarsus I, without vestiture; femur one half as long as coxa, basal third of segment bulbous, separated from telofemur by a distinct constriction and an incomplete suture, telofemur expanding from base to apex and bearing four setae three of which are situated on apical fourth of segment the other near constriction separating basifemur and telofemur; tibia as long as femur, sides slightly convex, with one seta at basal third and three at apical third of segment; tarsus three-fourths as long and one half as broad as tibia, sides subparallel for entire length of segment, with three setae; tarsus surmounted by a short, stout pretarsus bearing at its apex two strong, curved, spreading claws between which projects a broad empodium. Leg IV with coxa subtriangular, only slightly longer than broad, without vestiture, trochanter collarlike, broader than long, without adornment; third segment moderately slender, elongate, as long as tibiotarsus I, about one fifth as broad as long, tapering very slightly from base to mid-segment with margins parallel beyond this point, segment with one ventral seta one half as long as segment, located near outer margin one half width of segment before base, one ventral seta nearly as long as the latter located on outer margin the width of segment before apex; fourth segment one fifth as long as third segment, with one stout, ventral seta as long as third segment located near outer margin at apical third, one terminal seta with length equal to one and one-third times the length of subterminal seta, this equalling combined lengths of segments three and four. *Measurements:* Length of body from tips of palpi to apex of opisthosoma, 209μ; anterior margin of cephalothoracic hood to posterior extremity of opisthosoma, 189μ; tip of hood to main body suture, 47μ; width of body at main body suture, 106μ; width at anterior condyles of coxae III, 122μ; distance between anterior condyles of coxae III, 52μ; greatest distance between coxae IV, 12μ.

Holotype: Male, Washington, D. C., Aug. 26, 1950, E. W. Baker, hibiscus.

Allotype: Female, same data as holotype.

Location of types: Snow Entomological Museum, University of Kansas.

Although this species was not available in series for study, the present writer feels that it is distinct enough for describing and naming at this time. The two type specimens are the only members of this species examined.

In general appearance this species resembles most closely *T. smithi* and *T. randsi.* In the males it is most readily distinguished from these and other members of the Setifer Group, except *T. laminifer,* by the elongate second and third dorsal hysterosomal setae. In *T. laminifer* the second ventral hysterosomal setae are situated on apodemes IV, whereas in *T. sulcatus* they are some distance laterad from these apodemes. The male hind leg is somewhat similar to that of *T. smithi* but differs from the latter species in having the tactile tibial seta relatively short. Females are distinguished from closely related forms on the basis of details in the chaetotaxy of tibiotarsus I. Also in this species the dorsal hysterosomal setae of pairs one and two are significantly longer than the other dorsal setae on this portion of the body.

Tarsonemus cryptocephalus (Ewing), new combination

(Plates 12, 19 and 23)

Pseudotarsonemoides cryptocephalus Ewing, 1939, U. S. Dept. Agr. Tech. Bull., 653, p. 9.

Male: Body broadly oval, broadest in line with anterior condyles of coxae III; apodemes distinct and well-defined; genital papilla considerably larger than capitulum; anal plate large and distinct. Apodemes I short, extending in posteromedial directions from innermost angles of coxae I, converging medially to form a Y-shaped juncture with anterior extremity of median apodeme. Apodemes II subparallel to apodemes I for most of their lengths, extending from innermost angles of coxae II and curving to posterior just before convergence with median apodeme, terminating abruptly a short distance beyond the curves. Transverse apodeme strong and distinct, extending posteriorly from outer basal angles of coxae II for a short distance then curving to transect body without interruption slightly anterior to main body suture. Anterior median apodeme strong and distinct for anterior half of its length becoming interrupted and indistinct posteriorly, extending from point of convergence of apodemes I almost to transverse apodeme. Apodemes III extending in anteromedial directions from outer anterior margins of coxae III for a distance equal to length of coxa III, curving inward at these points at nearly a right angle and continuing to junctures with apodemes IV, these anterior extremities of apodemes III being the width of genu II behind transverse apodeme. Apodemes IV subparallel to apodemes III, extending from anterolateral angles of coxae IV to juncture with apodemes III, curving abruptly mesad slightly beyond juncture and terminating just before uniting at midbody. Posterior median apodeme distinct for its entire length, extending from point slightly behind mesal extremities of apodemes IV to point in line with outer anterior angles of coxae IV, apodeme bifurcating at this point with each arm continuing posterolaterally to inner angles of coxae IV. Dorsum of propodosoma extending forward to form a cephalothoracic hood which projects over basal two thirds of capitulum, anterior margin of hood broadly truncate, this margin being as broad as capitulum. *Dorsal chaetotaxy:* Propodosoma with first pair of dorsal setae slightly longer than combined lengths of genu and tibia II, situated on anterolateral angles of cephalothoracic hood; second pair of setae slightly longer than setae of first pair, located behind and slightly laterad from the latter a distance equal to the length of first seta; third pair of setae three times as long as setae of second pair, located directly behind the latter a distance equal to one half distance separating first and second setae; fourth pair of dorsal propodosomal setae three fourths as long as first setae and not as stout, situated laterad from third setae a distance equal to that separating second and third setae. Hysterosoma with first pair of setae nearly as long as first propodosomals, located on lateral margins of body the length of seta behind main body suture; setae of second pair one and two-thirds times as long as first hysterosomals; third pair of setae slightly shorter than second pair; fourth pair of dorsal hysterosomal setae one half as long as second setae, located near lateral margins of genital papilla near mid-length of papilla. *Ventral chaetotaxy:* First pair of ventral propodosomal setae short, length equal to basal width of tarsus I, located two thirds length of setae laterad from juncture of apodemes I; second pair of setae slightly longer than setae of first pair, situated the length of seta laterad from mesal extremities of apodemes II. First pair of ventral hysterosomal setae as long as second ventral propodosomals, located near anterolateral extremities of interapodemal areas defined by apodemes III and IV; second pair of setae subequal in size to setae of first pair, situated one third length of seta laterad from apodemes IV at posterior two fifths of apodemes. *Capitulum:* Subcordate with posterior margin rounded truncate; length including projecting palpi, 35μ; greatest width, measured at basal third of capsule, 23μ. Palpi moderately short and robust, indistinctly segmented and ornamented. Chelicerae styliform, projecting between but not beyond apices of palpi; cheliceral sheaths without striae. Dorsal setae with length nearly equal to one half width of capitulum, situated on anterolateral extremities of capsule. Ventral setae about one half as long as dorsal setae, located near bases of palpi and separated from each other by a distance slightly less than their combined lengths. *Legs:* Anterior pairs moderately long and robust, subequal in size. Leg I with coxa subquadrangular, broader than long, without vestiture; femur robust, one and one-half times as long as coxa, with two setae; genu as broad as long, with four setae; tibia twice as long as broad, with five setae; tarsus as long as tibia, with one short, clavate, annulated seta having length equal to basal width of segment, located dorsally near outer margin at base of segment, five normal setae; tarsus surmounted by a slender, elongate pretarsus bearing at its apex a curved claw and a broad empodium. Leg II with coxa subquadrangular, about twice as broad as long, without vestiture; femur robust, slightly longer than broad at base, with two setae; genu as broad as long, with four setae; tibia slightly longer than broad, with three setae; tarsus as long as tarsus I, tapering from base to narrowly rounded apex, with one short, clavate, sensory seta with length equal to two thirds basal width of segment, located dorsally near outer margin at base of segment, four normal setae; tarsus surmounted by a slender pretarsus bearing at its apex two curved, spreading claws between and beyond which projects a broad empodium. Leg III with coxa relatively short and broad, length equal to three fifths greatest width, as long as combined lengths of tibia and tarsus II, without vestiture; femur slightly longer than width of coxa, basifemur expanded, bulbous, separated from telofemur by an incomplete suture, telofemur with one seta; genu about one half as long as femur, slightly longer than broad, with three setae; tibia one and one-third times as long as genu, twice as long as broad, with three setae; tarsus as long as tibia, with four setae; tarsus surmounted by a slender, elongate pretarsus bearing at its apex two moderately sized, spreading, curved claws between and beyond which projects a broad empodium. Leg IV with coxa subtriangular, slightly broader than long, with one long, ventral seta; femur moderately long and stout, length equal to combined lengths of genu, tibia and tarsus III, about one half as broad at base as long, width at apex nearly two thirds width at base, inner margin curved inward at nearly a right angle just before base of segment, dorsal seta with length equal to apical width of segment and located on outer margin the length of seta from apex of segment, one short ventral seta one half as long as dorsal seta, situated on inner margin at basal two fifths, one ventral seta two and one-half times as long as dorsal seta, situated near inner margin at apex of segment; tibia robust, length slightly greater than apical width of femur, three fourths as broad as long, outer margin strongly convex and about twice as long as concave inner margin, segment with one rodlike, sensory seta with length equal to apical width of segment, situated dorsally near outer margin at apical third, one long tactile seta as long as leg IV, situated ventrally near outer distal margin of segment; tarsus small, collarlike, twice as broad as long, with one small ventral seta and two small dorsal setae; tarsus surmounted by a strong, curved claw nearly as long as tibia. *Genital papilla:* Subcordate with anterior margin rounded and emarginate medially; length including projecting appendages, 40μ; greatest width, measured at anterior fourth of papilla, 32μ. *Anal plate:* Large and conspicuous; central disc ovate, with greatest dimension equal to basal width of tarsus III, three strong apodemes radiating from disc each slightly longer than disc, with one extending caudally from posterior margin of disc and the remaining two extending anterolaterally from anterior margin of disc. *Measurements:* Total length, from tips of palpi to tips of appendages of genital papilla, 178μ; anterior margin of cephalothoracic hood to apex of genital papilla, 162μ; anterior margin of hood to main body suture, 46μ; width of body at main body suture, 79μ; greatest width of body, measured at anterior extremities of coxae III, 101μ.

Female: Body short, oval, broadest at mid-length. Legs comparatively long and moderately stout; anterior pairs subequal in size; hind coxae widely separated, with distance between innermost angles of coxae IV only slightly less than twice width of coxa. Apodemes weak and indistinct, those of legs I slightly longer than genu I, extending in posteromedial directions from innermost angles of coxae I converging medially to form an indistinct Y-shaped juncture with anterior extremity of median apodeme. Apodemes II one and one-half times as long as apodemes I and subparallel to the latter, extending from innermost angles of coxae II to points the width of genu I laterad from median apodeme, terminating here indistinctly. Transverse apodeme weak, extending in a smooth transverse curve which transects body at a point the length of tibiotarsus I behind mesal extremities of apodemes II, lateral extremities of transverse apodeme curving gently forward directed toward posterior basal angles of coxae II but terminating before reaching these coxae. Anterior median apodeme very weak from its anterior extremity at juncture of apodemes I to point in transverse alignment with mesal extremities of apodemes II, strong and conspicuous for a short distance in this area, losing visibility posterior from this point. Apodemes III strong and conspicuous for a short distance, extending anteromedially from anterior condyles of coxae III, losing distinctness just before contacting transverse apodeme. Apodemes IV indistinct for most of their lengths, extending anteromedially from points the basal width of tarsus II mesad from inner margins of coxae III at distal thirds of these segments to juncture with median apodeme opposite apical thirds of coxae III. Posterior median apodeme only visible for a short distance, extending in posterior direction from point of juncture of apodemes IV, terminating indistinctly at a point slightly posterior to apical thirds of coxae III. A faint suture transects propodosoma dorsally at its anterior third separating a broadly rounded cephalothoracic hood from remainder of propodosoma, the hood projecting over basal third of capitulum. Hysterosomal sutures distinct dorsally only in opisthosoma where three sutures transect the body clearly dividing opisthosoma into three distinct segments, the first of these sutures in vicinity of coxae IV, the remaining two situated to make the segments formed almost of equal length. Stigmatal openings small but distinct, situated dorsolaterally just posterior to suture separating cephalothoracic hood from remainder of propodosoma. Pseudostigmatic organs with expanded apices subspherical, these expansions with diameters slightly greater than length of slender pedicels; areoli with semicircular basal plates with diameters nearly equal to diameters of expanded apices of organs, these plates densely punctate. *Dorsal chaetotaxy:* First pair of dorsal propodosomal setae stout, length equal to combined lengths of tibiotarsus and pretarsal elements of leg I, situated near anterolateral margins of cephalothoracic hood and separated from each other by a distance equal to length of seta; second pair of setae one and one-third times as long as leg II, situated the length of tarsus II from lateral margins of body slightly less than one half the distance from stigmatal openings to main body suture. First pair of dorsal hysterosomal setae nearly as long as first propodosomals but not as robust, situated on lateral margins of body the length of seta behind main body suture; second dorsal hysterosomals subequal in size to setae of first pair, situated in transverse alignment with anterior thirds of coxae III; third, fourth and fifth pairs of dorsal hysterosomal setae stout, subequal in size, about one half as long as second pair; sixth setae also stout but three fourths as long as second setae.

Ventral chaetotaxy: Propodosoma with first pair of setae having length equal to basal width of tibiotarsus I, situated one half length of seta laterad from Y-shaped juncture of apodemes I and median apodeme; second ventral propodosomal setae one and one-half times as long as setae of first pair, situated on apodemes II at their mid-lengths. First pair of ventral hysterosomal setae as long as second propodosomals located on transverse apodeme and separated from each other by a distance equal to their combined lengths; second pair of setae subequal in size to setae of first pair, situated on posterior extremities of apodemes IV; third pair of setae short, located near tip of opisthosoma. *Capitulum:* Subcordate with posterior margin slightly emarginate; length, including projecting palpi, 37μ; greatest width, measured at basal third of capsule, 30μ. Dorsal setae with length equal to length of genu I, situated near anterolateral margins of capsule and separated from each other by a distance equal to length of seta. Ventral setae slightly shorter than dorsal setae, located near bases of palpi and separated from each other by a distance equal to length of seta. Palpi short and stout, indistinctly segmented and ornamented. Styliform chelicerae projecting between and slightly beyond palpi; cheliceral sheaths without striae. *Legs:* Anterior pairs moderately long and stout, subequal in size. Leg I with coxa subquadrangular broader than long, without vestitures; femur robust, slightly longer than broad, with four setae; genu slightly longer than broad, with four setae; tibiotarsus robust, about twice as long as genu and three times as long as broad at base, with one short, clavate, annulated seta having length equal to one third basal width of segment, located dorsally near outer margin the length of seta from base of segment, one small, capitate seta nearly as long as the former, situated immediately mesad from the clavate seta, one short, rodlike seta slightly longer than clavate seta, situated immediately beside the capitate seta, one large, clavate, annulated seta having length equal to three fourths basal width of segment, situated dorsally near outer margin just distad from mid-segment, one short, ventral, spurlike process projecting from inner apical margin of segment, ten normal setae on segment; tibiotarsus subtending a short, curved claw and a small empodium. Leg II with coxa subquadrangular, as broad as long, without vestiture; femur robust, as broad at base as long, with three setae; genu as broad as long, with one stout, spinelike seta as long as segment, situated dorsally near inner basal margin of segment, two normal setae; tibia one and one-half times as long as broad, with four setae; tarsus slightly longer than tibia, tapering from base to narrowly rounded apex, with one clavate, annulated seta as long as basal width of segment, located dorsally near outer margin one half length of seta from base of segment, three normal setae; tarsus surmounted by a short, broad pretarsus with lateral margins imbricated and bearing apically a pair of strong, curved, spreading claws between and beyond which projects a small empodium. Leg III with coxa broad and oval, its length equal to combined lengths of genu and tibiotarsus I, nearly one half as broad as long, without vestiture; femur one half as long as coxa, its basal third separated from distal portion by an incomplete suture, this basifemur subglobose and telofemur expanding from base to apex, the latter bearing three setae; tibia as long as femur, tapering slightly from mid-segment toward apex, with four setae; tarsus three fourths as long as tibia, one fifth as broad as long, sides subparallel for entire length of segment, with three setae; tarsus surmounted by a short, broad pretarsus with lateral margins imbricated in appearance, the segment bearing at its apex two strong, curved, spreading claws between and beyond which projects a small empodium. Leg IV with coxa subquadrangular, one and one-half times as broad as long, without vestiture; trochanter small, collarlike, nearly twice as broad as long, without setae; third segment slender, elongate, one and one-half times as long as tibia III, with one ventral seta one fourth as long as segment, located near outer margin the width of segment from its base, one ventral seta two thirds as long as segment, situated near outer margin at apical third; fourth segment one third as long as third segment, with one stout, ventral seta as long as third segment, situated at apical third of segment, one terminal seta nearly twice as long as leg IV. *Measurements:* Tips of palpi to apex of hysterosoma, 170μ; anterior extremity of cephalothoracic hood to apex of hysterosoma, 137μ; anterior extremity of hood to main body suture, 61μ; width of body at anterior condyles of coxae III, 93μ; distance between anterior condyles of coxae III, 54μ; distance between innermost margins of coxae IV, 14μ.

Types: Collected at New York in shipment of avocados arriving from Chile, S. Am., July 3, 1934, Inman and Whitlock, collectors.

Location of types: Cotype series with the exception of two females in U. S. National Museum, these two specimens in Snow Entomological Museum, University of Kansas.

The above description of the male was made from a specimen in the U. S. National Museum series of cotypes. The description of the female was made from a cotype female now in the Snow Entomological Museum. The cotype series included several mites of both sexes on a single slide which have been remounted one mite per slide. One of these remounted male specimens, slide number 1117-A is hereby designated lectotype.

Specimens identified by the present writer as this species include only the cotype series.

Tarsonemus laminifer Ewing

(Plates 10 and 19)

Tarsonemus laminifer Ewing, 1939, U. S. Dept. Agr. Tech. Bull., 653, p. 37.

Male: Body broad, oval, broadest at posterior third; legs of moderate length, robust; apodemes strong and clearly defined; genital papilla large, nearly as large as capitulum. Apodemes I as long as tibia I, extending in posteromedial directions from innermost angles of coxae I, converging medially to form a Y-shaped juncture with median apodeme. Apodemes II one and one-half times as long as apodemes I and subparallel to the latter, extending from anterior basal condyles of coxae II, curving abruptly caudad just before intersection with median apodeme and terminating just beyond this point. Anterior median apodeme strong and distinct, extending from juncture of apodemes I almost to main body suture, its continuity broken for a short distance near median extremities of apodemes II. Transverse apodeme absent. Apodemes III strong and thickened, extending in anteromedial directions from anterior condyles of coxae III, curving inwardly at anterior thirds and slightly recurved just before intersecting apodemes IV. Apodemes IV distinct for entire lengths, extending from outer anterior angles of coxae IV to point of juncture with apodemes III a short distance behind main body suture, curved abruptly inward at this point to join with anterior extremity of median apodeme. Posterior median apodeme distinct for its entire length, extending from point one half length of tibia II behind main body suture to point in line with mid-lengths of coxae III, bifurcate at this point with each arm of apodeme continuing to inner anterior angles of coxae IV. Dorsum of propodosoma with anterior margin broadly and angularly truncate projecting to cover only extreme posterior end of capitulum. *Dorsal chaetotaxy:* First pair of dorsal propodosomal setae as long as combined lengths of tibia and tarsus I, slightly longer than anterior margin of dorsal propodosomal shield, situated one fifth length of seta behind anterior margin of shield and separated from each other by this distance; setae of second pair slightly longer than first setae situated almost directly behind the latter a distance equal to one fifth length of second seta; third setae more than twice as long as second setae, situated behind and slightly laterad from setae of second pair a distance almost twice that separating first and second setae; fourth pair of dorsal propodosomal setae slightly longer than setae of second pair, located laterad from third setae a distance equal to one half the distance separating first and second setae. First pair of dorsal hysterosomal setae slightly longer than fourth propodosomals, located near margins of body one third length of seta behind main body suture; second and third hysterosomals quite long, five sixths as long as third propodosomals; fourth pair of dorsal hysterosomal setae about one half as long as first propodosomals, located near lateral extremities of genital papilla at its mid-length. *Ventral chaetotaxy:* First pair of ventral propodosomal setae with length equal to length of genu II, located two thirds length of seta in posterolateral direction from juncture of apodemes I; second propodosomals with size subequal to setae of first pair, situated midway between apodemes II and main body suture slightly more than length of seta from median apodeme. First pair of ventral hysterosomal setae subequal in length to second ventral propodosomals, situated on apodemes III two thirds length of seta from point of juncture of apodemes III and IV; second hysterosomals with size equal to setae of first pair, situated on apodemes IV at posterior two fifths. *Capitulum:* Subcordate with posterior margin slightly emarginate. Length including projecting palpi, 24μ; greatest width, measured at posterior third of capsule, 24μ. Dorsal setae short, length equal one third width of capitulum, located near anterolateral angles of capsule. Ventral setae one-half as long as dorsal setae, situated in transverse alignment with the latter and separated from each other by a distance equal to three times length of seta. Palpi short and stout, indistinctly segmented and ornamented, projecting beyond apex of capitulum for a short distance. Chelicerae elongate, styliform, extending a short distance beyond tips of palpi; cheliceral sheaths without striae. *Legs:* Leg

I with coxa subquadrangular, broader than long, without vestiture; femur slightly longer than broad, with three short and one long setae; genu about as broad as long, with four setae; tibia four fifths as broad as long, with one small, clavate, annulated sensory seta, its length nearly equal to one half basal width of segment, situated dorsally near outer margin the length of seta from base of segment, five normal setae; tarsus one and one-third times as long as tibia, three times as long as broad at base, tapering from base to narrowly rounded apex, with one lanceolate, annulated seta having length slightly greater than basal width of segment, located dorsally near outer margin just before base of segment, seven normal setae; tarsus surmounted by a slender pretarsus, as long as basal width of tarsus and bearing at its apex a small, curved claw and small empodium. Leg II with coxa subquadrangular, one and one-third times as broad as long, without vestiture; femur subequal in size to femur I, with four setae; genu broader than long, with four setae; tibia as long as genu, slightly longer than broad at base, with four setae; tarsus slightly less than twice as long as tibia, width at base slightly less than one half length of segment, with one clavate, annulated seta with length equal to basal width of segment, located dorsally near outer margin at base of segment, three normal setae; tarsus surmounted by a slender, moderately long pretarsus bearing at its apex a pair of small, curved, spreading claws between and beyond which projects a small empodium. Leg III with coxa broad, elongate, one half as broad as long, without vestiture; femur three fifths as long as coxa about one-half as broad as long, with one seta; genu as broad as long, one half as long as femur, with three setae; tibia slightly longer than genu, with four setae; tarsus one and one-half times as long as tibia, four times as long as broad at base, tapering from base to narrowly rounded apex, with two setae; tarsus surmounted by a short, narrow pretarsus which bears at its apex two small, curved, spreading claws between and beyond which projects a small, broad empodium. Leg IV with coxa subquadrangular, two thirds as long as broad, with one seta; femur moderately long and broad, length slightly greater than twice width of coxa, about twice as long as greatest breadth, widest at basal two fifths, segment narrowing abruptly by a curving inward of inner margin at almost a right angle just before apex curving again to form a right angle and continuing to apex of segment, width of segment at apex equal to one half width at base, with one dorsal seta having length equal to three fifths greatest width of segment, located near outer margin slightly less than one-half length of seta from apex of segment, one ventral seta two thirds as long as dorsal seta, situated near inner margin at basal two fifths, one ventral seta nearly one and one-half times as long as dorsal seta, situated one half length of seta from apex of segment, one third length of seta from inner margin; tibia about one third as long as femur, one half as broad as long, outer margin convex and nearly twice as long as concave inner margin, segment with one clavate, annulated seta slightly shorter than width of segment, situated dorsally near outer margin at apical fifth, one stout, tactile seta as long as combined lengths of femur and tibia, situated ventrally at apical third; tarsus short, collarlike, with two short dorsal setae and one short ventral seta; tarsus supports a strong, curved claw about as long as tibia. *Genital papilla:* Subcordate with anterior margin rounded and having a conspicuous acuminate emargination, posterior margin rounded truncate; length including projecting appendages, 26µ; greatest width, measured at mid-length, 26µ. *Measurements:* Length from tips of palpi to posterior extremity of genital papilla, 132µ; main body suture to apex of genital papilla, 64µ; anterior margin of propodosomal hood to main body suture, 47µ; width of body at main body suture, 77µ; greatest width of body, measured at anterior condyles of coxae III, 87µ.

Female: Due to considerable confusion relating to the association of the sexes of this species, as explained below, it seems ill advised at this time to offer a redescription of the female.

Types: Belle, Maryland, Oct. 16, 1933, F. F. Smith, on strawberry. The type slide, U.S.N.M. number 1130, contains four males definitely identified as *T. laminifer* and six females. One of the male specimens has been encircled by the present writer and this specimen is hereby designated lectotype. Due to the poor orientation and position of these six females on the type slide, positive identification could not be made. However, it appears that one specimen is *X. viridis* and one specimen *T. randsi.* The others are unidentifiable to any of the species described for the first time or redescribed in this paper. It is possible, if not probable, that these remaining four specimens are the females of *T. laminifer,* but in the light of the fact that a second slide bearing identical data was found to include one male and four females of *T. viridis,* one male of what this writer believes to be *T. unguis* and one male of *T. laminifer* it seems advisable to reserve association of females with *T. laminifer* and *T. unguis* until such a time as this can be accomplished on substantial grounds.

Location of types: U. S. National Museum, slide number 1130. The description of the male given above was made from a specimen remounted from a slide bearing data identical to that on the type slide. The figure of the whole male (Plate 10) was likewise drawn from this specimen. However, the male hind leg (Plate 19) was drawn from one of the type males which had this appendage displayed to good advantage. Measurements of this particular type male specimen are as follows: Tips of palpi to apex of genital papilla, 153μ; tips of palpi to main body suture, 78μ; width of body slightly behind main body suture, 100μ; capitulum 30μ long and 30μ wide; genital papilla 26μ long and 28μ wide.

The male of this species appears to resemble *T. sulcatus* and *T. occidentalis* more closely than other members of the Setifer Group. It may be readily distinguished from *T. sulcatus* in that the latter species does not have the second pair of ventral hysterosomal setae situated on apodemes IV as well as by distinct differences in the shape of the hind legs. It differs from *T. occidentalis* in having the second dorsal hysterosomal setae quite long, these being as short as the setae of the first pair in *T. occidentalis,* and besides differences in the shape of legs IV, the dorsal femoral seta is longer than the ventral setae in *T. occidentalis* whereas it is shorter than the ventral setae in *T. laminifer.*

Tarsonemus confusus Ewing

(Plates 13, 20 and 24)

Tarsonemus confusus Ewing, 1939, U. S. Dept. Agr. Tech. Bull., 653, p. 26.
Tarsonemus assimilis Banks, 1914, Jour. Ent. and Zool., vol. 6, no. 2, p. 60; Rutherford, 1913, Trop. Agr. Peradeniya, vol. 41, no. 6, p. 490 (*T. assimilis* Banks, MS). (new synonymy.)

Male: Body short, oval, broadest at anterior condyles of coxae III; legs moderately long and robust, anterior pairs subequal in size; apodemes distinct and well defined; genital papilla large and conspicuous, larger than capitulum; anal plate large and distinct. Apodemes I as long as genu I, extending in posteromedial directions from innermost angles of coxae I and converging at anterior extremity of median apodeme to form a Y-shaped juncture with the latter. Apodemes II about twice as long as apodemes I and subparallel to the latter, extending from innermost angles of coxae II to juncture with median apodeme at point the length of apodeme II from anterior extremity of median apodeme. Transverse apodeme strong, transecting body in a smooth, uninterrupted arc just anterior to main body suture, the lateral extremities of apodeme being the length of genu I from lateral margins of body. Anterior median apodeme strong and distinct from point of juncture of apodemes I to point of intersection of apodemes II, less distinct posterior to the latter. Apodemes III extending in anteromedial directions from anterior condyles of coxae III curving gently inward at anterior thirds to join apodemes IV at points the length of femur I behind main body suture. Apodemes IV subparallel to apodemes III for most of their lengths, extending from outer basal angles of coxae IV to juncture with apodemes III, here curving inward to converge at anterior extremity of median apodeme. Posterior median apodeme with anterior extremity at point of convergence of apodemes III, this being the length of femur I behind main body suture, extending posteriorly to point in transverse alignment with anterior extremities of coxae IV, here bifurcating with arms of apodeme diverging and continuing to inner basal angles of coxae IV. A distinct hysterosomal suture transects body dorsally in region of anterior fifth of genital papilla. Dorsum of propodosoma narrowing anteriorly and projected forward to form a cephalothoracic hood which covers basal fifth of capitulum, anterior margin of hood with dimension slightly less than greatest width of capitulum, equal to combined lengths of genu and tibia I. *Dorsal chaetotaxy:* First pair of dorsal propodosomal setae slightly longer than combined lengths of tibia and tarsus I, situated one third length of seta behind anterior margin of hood and separated from each other by this distance; second pair of setae three fourths as long as setae of first pair, length about equal to the dimension of truncated anterior margin of hood, situated nearly the length of seta behind and slightly laterad from setae of first pair; third pair of setae nearly three times as long as setae of first pair, situated behind and slightly laterad from second setae a distance equal to three fourths the distance separating first and second setae; fourth pair of dorsal propodosomal setae slightly longer than setae of second pair, located one third length of seta laterad from third setae. First pair of dorsal hysterosomal setae as long as first propodosomals, situated near lateral margins of body three fourths length of seta from main body suture; second pair of setae as long as setae of first pair; third pair of setae three fourths as long as first pair; fourth pair of setae slightly shorter than setae of third pair and located near lateral margins of genital papilla at mid-length of papilla. *Ventral chaetotaxy:* First pair of ventral propodosomal setae as long as genu I, situated one half length of seta laterad from juncture of apodemes I; second pair of setae as long as first setae, located two thirds length of seta posterior to apodemes II at mid-lengths of these apodemes. First pair of ventral hysterosomal setae about twice as long as first ventral propodosomals, situated immediately posterior to arclike anterior extremities of apodemes III; second ventral hysterosomals as long as setae of first pair, located on apodemes IV at posterior thirds of these apodemes. *Capitulum:* Small, subcordate with posterior margin rounded truncate and with a slight mesal emargination; length, including projecting palpi, 20μ; greatest width, measured at posterior third of capitulum, 16μ. Dorsal setae with length equal to one fourth width of capitulum, situated near anterolateral extremities of capsule. Ventral setae slightly shorter than dorsal setae, located near bases of palpi and separated from each other by a distance equal to length of seta. Palpi short and stout, projecting slightly beyond apex of capitulum, indistinctly segmented and ornamented. Chelicerae short and styliform, projecting between but not beyond palpi; cheliceral sheaths without striae. *Legs:* Leg I with coxa subquadrangular, two thirds as long as broad, without vestiture; femur three fourths as broad as long, with three setae; genu about as broad as long, with four setae; tibia one and one-third times as long as broad, with one small, clavate, annulated seta with length equal to two-thirds basal width of segment, situated middorsally one half length of seta from base of segment, one rodlike seta slightly longer than clavate seta, located dorsally near outer margin one half length of seta from base of segment, one capitate seta as long as clavate seta, situated between the latter and the rodlike seta, four normal setae; tarsus one and one-third times as long as tibia, tapering from base to narrowly rounded apex, with one clavate seta with length equal to basal width of segment, located middorsally one half length of seta from base of segment, seven normal setae; tarsus surmounted by a short, slender pretarsus which subtends a small, curved claw and a small empodium. Leg II with coxa subquadrangular, broader than long, without vestiture; femur relatively slender, nearly twice as long as broad, about one-half as long as femur, with three setae; tibia slightly longer than broad, with four setae; tarsus one and one-half times as long as tibia, tapering from base to narrowly rounded apex, with one large, clavate, annulated seta slightly longer than basal width of segment, situated dorsally near outer margin one third length of seta from base of segment, one short, spinelike seta with length equal to one half basal width of segment, located dorsally near outer margin at base of segment, four normal setae; tarsus surmounted by a short, slender pretarsus bearing at its apex two large, curved, spreading claws between and beyond which projects a broad, bilobed empodium. Leg III with coxa broad and long, more than twice as long as broad, without vestiture; femur three fifths as long as coxa with basal third of segment bulbous and separated from apical portion by a distinct constriction and a partial suture, the telofemur expanding slightly from base toward apex and with one seta; genu slightly longer than broad, one-half as long as femur, with three setae; tibia about one and one-half times as long as genu, with four setae; tarsus as long as tibia, tapering from base to narrowly rounded apex, with three setae; tarsus surmounted by a short, slender pretarsus which subtends two large, curved, spreading claws between and beyond which projects a broad, bilobed empodium. Leg IV with coxa subquadrangular, three fourths as long as broad, with one ventral seta as long as segment; femur about twice as long as coxa, as long as combined lengths of genu, tibia and tarsus I, width at base equal to one half length and twice width at apex, outer margin of segment slightly convex for most of its length, inner margin slightly concave from apex to basal fifth and bent sharply inward at this latter point presenting a distinctly angulate appearance, segment with one dorsal seta four fifths as long as segment, situated near outer margin the distal width of segment before apex, one ventral seta about three fourths as long as dorsal seta, situated near inner margin slightly more than distal width of segment before apex, one ventral seta one half as long as the former ventral seta, located on inner margin slightly proximad from mid-segment; tibia short, nearly as broad as long, with one dorsal, rodlike seta one half as long as segment, located near outer margin at mid-segment, one tactile seta slightly longer than femur, situated dorsally near outer margin at apex; tarsus short, collarlike, one and one-half times as broad as long, with two short dorsal setae and one short ventral seta; tarsus subtends a short, pointed claw which is nearly as broad at base as long, its length slightly less than two thirds length of tibia. *Genital papilla:* Large, subcordate, with anterior margin deeply emarginate medially, posterior margin rounded truncate; length, including projecting appendages, 24μ; greatest width, measured at anterior fifth, 22μ. *Anal plate:* Large and well-defined, longitudinal dimension of central disc equal to length of claw IV, triradiate apodemes strong and each as long as tibia IV. *Measurements:* Length of body from tips of palpi to apex of genital papilla, 143μ; anterior margin of cephalothoracic hood to apex of genital papilla, 124μ; anterior margin of hood to main body suture, 40μ;

width of body at main body suture, 65μ; width of body at anterior condyles of coxae III, 69μ.

Female: Body broadly oval, broadest at mid-length. Legs of moderate length and robustness; legs II shorter but equally as robust as legs I; legs IV with coxae separated by a distance equal to length of coxa IV and terminal segment of leg IV not reaching to margin of body. Apodemes relatively conspicuous though their limitations are indistinct. Apodemes I strong and distinct for their entire lengths, as long as tibia II, extending in posteromedial directions from innermost angles of coxae I, converging medially to form a Y-shaped juncture with median apodeme. Apodemes II about one and one-half times as long as apodemes I and subparallel to the latter, extending from innermost angles of coxae II to points the basal width of tibiotarsus I laterad from median apodeme. Transverse apodeme strong and distinct for its entire length, transecting body immediately anterior to main body suture, its lateral extremities curved slightly forward shortly before their terminations, the latter being the basal width of genu II from lateral margins of body, the apodeme having two distinctive notches near mid-length. Anterior median apodeme extending from point of juncture of apodemes I to point in transverse alignment with mesal extremities of apodemes II, continuing caudad from here obscurely for a short distance. Apodemes III short, length equal to length of genu I, extending in nearly mesal directions from anterior condyles of coxae III and expanding to fan-shaped apices. Apodemes IV relatively indistinct and interrupted for most of their lengths, extending in anteromedial directions from points the basal width of tibiotarsus I mesad from inner margins of coxae III at posterior thirds of these segments, the apodemes converging to join median apodeme at a point nearly in transverse alignment with anterior extremities of coxae III. Posterior median apodeme extending from point midway between inner apical angles of coxae IV to a point slightly less than the basal width of tibiotarsus I beyond juncture of apodemes III, its anterior extremity bifurcate with each fork very short and projected in an anterolateral direction, posterior third of apodeme and portion anterior to juncture of apodemes III much weaker than remainder of apodeme. Three distinct sutures transect hysterosoma dorsally, the first in region of coxae IV, the remaining two on opisthosoma. Dorsum of propodosoma projected forward to form a broadly rounded cephalothoracic hood which covers basal half of capitulum. Pseudostigmatic organs with expanded apices broadly ovate and equal in length to the slender pedicels. Stigmatal openings conspicuous, their diameters equal to one third the greatest width of apical expansions of pseudostigmatic organs, situated dorsolaterally on propodosoma just posterior to lateral indentations marking posterior limits of hood; tracheal pouches conspicuous, oblong in shape, single-lobed, situated in region of juncture of apodemes I. *Dorsal chaetotaxy:* First pair of dorsal propodosomal setae slightly longer than capitulum, situated near lateral margins of hood one third the distance from stigmatal openings to apex of hood, setae separated from each other by a distance equal to three fourths length of seta; second dorsal propodosomals very long, about two and one-half times as long as setae of first pair, located slightly more than one half the distance from stigmatal openings to main body suture and about this distance from lateral margins of body. First and second pairs of dorsal hysterosomal setae about two thirds as long as first propodosomals; third, fourth and sixth pairs of setae about one half as long as first pair; fifth pair one and one-half times as long as third pair. *Ventral chaetotaxy:* First pair of ventral propodosomal setae with length equal to length of tibia II, situated one third length of seta behind apodemes I at their mid-lengths; second ventral propodosomals as long as first pair, located on apodemes II at their mid-lengths. First pair of ventral hysterosomal setae with length equal to first propodosomals, situated just mesad from broad inner extremities of apodemes III; second ventral hysterosomals with length equal to setae of first pair, located at posterior extremities of apodemes IV; third pair of setae short, situated at apex of hysterosomal and separated from each other by their combined lengths. *Capitulum:* Relatively small and subcordate, with posterior margin slightly emarginate; length, including projecting palpi, 30μ; greatest width, measured at posterior fourth of capsule, 26μ. Dorsal setae with length equal to two fifths width of capitulum, situated near anterolateral margins of capsule and separated from each other by a distance equal to length of seta. Ventral setae slightly shorter than dorsal setae, located near bases of palpi and separated from each other by a distance equal to length of seta. Palpi relatively short and stout, indistinctly segmented and ornamented. Styliform chelicerae short, extending between and slightly beyond apices of palpi; cheliceral sheaths without transverse striae. *Legs:* Leg I with coxa subquadrangular, slightly broader than long, without vestiture; femur one and one-half times as long as broad, with one long, tactile seta one and one-half times as long as broad, situated ventrally near inner margin at base of segment, two normal setae; genu two thirds as long as femur, about one and one-half times as long as broad, with four setae; tibiotarsus slightly longer than femur, about three times as long as broad at base, tapering slightly from base toward broadly rounded apex, with one small, clavate, annulated seta with length slightly less than one half basal width of segment, located ventrally near outer margin at base of segment, one spinelike seta slightly longer than clavate seta, situated ventrally near outer margin one and two-thirds times length of seta from base of segment, one large, clavate, annulated seta with length slightly greater than basal width of segment, situated dorsally on outer margin at basal two fifths, one small, ventral spur on inner apical margin, one very long tactile seta, ten normal setae; tibiotarsus subtends a short pretarsus which bears at its apex a strong, curved claw and a large empodium. Leg II with coxa subquadrangular, slightly broader than long, without vestiture; femur robust, slightly longer than broad, with one stout, lanceolate seta one half as long as segment, situated dorsally near inner margin at apical fifth, two normal setae; genu one half as long as femur, as broad at base as long, with one stout, spinelike seta as long as segment, situated middorsally at base of segment, two normal setae; tibia as long as genu, slightly longer than broad, with four long setae; tarsus one and one-half times as long as tibia, tapering from its broad base to mid-segment with sides subparallel from this point to broadly rounded apex, with one stout, spinelike seta having length equal to one half basal width of segment, situated on outer margin of segment at base, one clavate, annulated seta slightly longer than spinelike seta, located dorsally on outer margin immediately distad to spinelike seta, one spurlike projection with dimensions subequal to spinelike seta, situated ventrally near inner margin at apex, four normal setae; tarsus surmounted by a short, slender pretarsus which subtends two large, curved, spreading claws between and beyond which projects a large, bilobed empodium. Leg III with coxa slender, elongate, about four times as long as broad, length equal to combined lengths of femur, genu and tibia II, without vestiture; femur one half as long as coxa, basal two fifths of segment bulbous and separated from remainder of segment by a distinct constriction and a partial suture, with the telofemur expanding from constriction to apex and bearing four setae; tibia as long as femur, tapering slightly from base to apex, with four setae; tarsus slender, elongate, about five times as long as broad with lateral margins subparallel, segment with three setae; tarsus surmounted by a short, slender, pretarsus with imbricated lateral margins and subtending two large, curved, spreading claws between and beyond which projects a large empodium. Leg IV with coxa subtriangular, as broad at apex as long, without vestiture; trochanter small, collarlike, twice as broad as long, without setae; third segment very slender and elongate, slightly dilated at base and apex, about seven times as long as broad at mid-length, with one ventral seta two fifths as long as segment situated on inner margin near base, one ventral seta one fourth as long as segment located near outer margin at apical fourth; fourth segment one fourth as long as third segment, with one stout, ventral seta four times as long as segment, located at mid-segment, terminal seta about as long as leg IV. *Measurements:* Length of body from tips of palpi to apex of hysterosoma, 186μ; anterior extremity of cephalothoracic hood to apex of hysterosoma, 172μ; anterior extremity of hood to main body suture, 54μ; width of body at main body suture, 91μ; width of body at anterior condyles of coxae III, 111μ; distance between innermost extremities of coxae IV, 10μ.

Types: Suitland, Maryland, Sept. 20, 1933, F. F. Smith (two males and two females mounted on a single slide). One of the male specimens has been encircled by the present writer and this specimen is hereby designated lectotype.

Location of types: U. S. National Museum (slide number 1124).

Material studied by the present writer in addition to the type series included specimens identified by the following data: Berkeley, Calif., Mar. 10, 1951, Carl H. Spitzer, in culture of *Fusarium oxysporium* var. *dianthi;* Fort Valley, Ga., July 14, 1949, Max R. Osburn, on pecan; Red Lion, N. J., Mar. 14, 1950, John P. Reed, corn husk; Salem, N. J., Aug. 15, 1949, John P. Reed, on tomato leaves; Flushing, L. I., N. Y., July 12, 1936, K. W. Cooper, from *Sporotrichium* cultures rearing *Pediculopsis;* Arlington Farm, Va., Aug. 12, 1937, Evinger and Grant, on black locust leaf; Prosser, Wash., Aug. 14, 1951, D. R. Malcom, on red clover.

The above description of the male was made from one of the Arlington Farm specimens and of the female from one of the Berkeley specimens.

The male of this species very closely resembles the male of *T. scaurus* but may be readily distinguished by the short claws on leg IV, these being long in *T. scaurus* and by the position of the second ventral hysterosomal setae, which, in *T. scaurus* are on apodemes II whereas in *T. confusus* they are some distance behind these apodemes. Both of these species have the inner margins of femora IV distinctly angulate near base of segment. The male of *T. simplex* is similar to *T. confusus* in most respects but lacks the angulate character of femora IV. Females of this species are most easily identified by the two distinct notches on the transverse apodeme. Many of the mites identified as *T. confusus* by Ewing (1939) were found by the present writer to be *T. scaurus* or some other species.

Tarsonemus waitei Banks

(Plates 13, 20 and 24)

Tarsonemus waitei Banks, 1904, Proc. Ent. Soc. Washington, vol. 14, no. 2, p. 96; Quaintance, 1912, U. S. Dept. Agr. Bur. Ent. and Plant Quarantine Bull., 97, pt. 6, p. 103; Rutherford, 1913, Trop. Agr. Peradeniya, vol. 41, no. 6, p. 490; Weiss, 1915, Ent. News, vol. 26, no. 4, p. 149; Ewing, 1915, U. S. Dept. Agr. Rept., 108, p. 104; Moznette, 1917, Jour. Agr. Res., vol. 10, no. 8, p. 373; Ewing, 1939, U. S. Dept. Agr. Tech. Bull., 653, p. 22.

Male: Body short and broadly oval, broadest at mid-length; legs short and stout, anterior pairs subequal in size; genital papilla larger than capitulum; anal plate large and rather conspicuous. Apodemes strong and clearly defined, those of legs I as long as genu I, extending in posteromedial directions from inner basal angles of coxae I, converging mesially to form a Y-shaped juncture with median apodeme. Apodemes II about twice as long as apodemes I and subparallel to the latter, extending from innermost angles of coxae II to juncture with median apodeme. Transverse apodeme moderately strong and distinct, transecting body just anterior to main body suture, its lateral extremities not reaching margins of body but curved forward toward posterior basal angles of coxae II and terminating just before reaching coxae. Apodemes III strong and conspicuous for their entire lengths, extending in anteromedial directions from anterior condyles of coxae III for a distance nearly equal to length of coxa III, then curving abruptly inward to intersect apodemes IV midway between point of incurving and median apodeme. Apodemes IV subparallel to apodemes III, extending from outer basal angles of coxae IV to point of intersection with apodemes III, this being the length of tibia I behind main body suture, here curving abruptly inward to intersect median apodeme at the anterior extremity of the latter. Posterior median apodeme extending from point of juncture of apodemes IV to inner basal angles of coxae IV, bifurcate at posterior fourth of its length. One conspicuous hysterosomal suture present, transecting body at about anterior two fifths of genital papilla. Dorsum of propodosoma with anterior margin broadly truncated and projecting over basal third of capitulum. *Dorsal chaetotaxy:* First pair of dorsal propodosomal setae with length equal to combined lengths of genu and tibia I, slightly shorter than width of anterior margin of propodosomal shield, situated two fifths length of seta behind anterior margin of shield and separated from each other by a distance equal to three fourths length of seta; second dorsal propodosomals one half as long as setae of first pair, situated posterior to and slightly laterad from the latter a distance equal to length of second seta; third pair of setae relatively short, length about one and one-third times the length of first setae, located in linear alignment with first and second setae two thirds the distance separating first and second setae behind the latter; fourth pair of dorsal propodosomal setae with size subequal to setae of third pair, situated laterad from setae of third pair a distance equal to that separating second and third setae. First pair of dorsal hysterosomal setae with size about equal to size of first propodosomals, situated near lateral margins of body two thirds length of seta behind main body suture; second dorsal hysterosomals slightly shorter than setae of first pair; third and fourth pairs of setae subequal in size, slightly shorter than second pair, the fourth pair situated at lateral margins of genital papilla just posterior to mid-length of papilla. *Ventral chaetotaxy:* First pair of ventral propodosomal setae with length equal to length of genu I, situated one half length of seta laterad from juncture of apodemes I; second pair of setae with size subequal to first setae, situated one half length of seta behind apodemes II at mid-lengths of apodemes. First pair of ventral hysterosomal setae as long as first propodosomals situated just behind apodemes III and slightly mesad from the curves of their anterior extremities; second pair of setae with size subequal to first setae, located on apodemes IV at posterior thirds of apodemes. *Capitulum:* Subcordate with posterior margin rounded and slightly emarginate; length, including projecting palpi, 26μ; greatest width, measured at basal third, 19μ. Dorsal setae with length equal to length of genu I, situated near lateral margins one half length of seta behind apex of capsule. Ventral setae with length subequal to that of dorsal setae, located near bases of palpi and separated from each other by a distance equal to length of seta. Palpi moderately long and robust, projecting a short distance beyond apex of capsule, indistinctly segmented and ornamented. Chelicerae styliform, projecting between but not beyond palpi; cheliceral sheaths without transverse striae. *Legs:* Anterior pairs relatively long and robust, slightly longer than propodosoma. Leg I with coxa subquadrangular, about one and one-half times as broad as long, without vestiture; femur stout, having length equal to width of coxa, with four setae; genu one half as long as femur, about as broad as long, with four setae; tibia slightly longer than genu, with one short, clavate, annulated seta having length equal to one third basal width of segment, situated dorsally near inner margin the length of seta from base of segment, one capitate seta nearly twice as long as clavate seta, situated immediately mesad from the latter, one rodlike seta slightly longer than clavate seta, situated immediately beside the latter, four normal setae; tarsus one and one-fourth times as long as tibia, tapering from base toward apex, with one small, clavate, annulated seta having length equal to one half basal width of segment, situated dorsally near outer margin one half length of seta from base of segment, seven normal setae; tarsus surmounted by a short, slender pretarsus bearing at its apex a small, curved claw and a small empodium. Leg II with coxa subquadrangular, twice as broad as long, without vestiture; femur short and stout, nearly as broad as long, with three setae; genu about one half as long as femur, slightly broader than long, with three setae; tibia slightly shorter than genu and slightly broader than long, with four setae; tarsus broad at base but tapering abruptly and being slender for most of its length, slightly longer than combined lengths of genu and tibia II, with one very large, broad, clavate, annulated seta having length slightly greater than basal width of segment and width equal to one half its length, situated dorsally near outer margin at base of segment, three normal setae; tarsus surmounted by a slender pretarsus bearing at its apex two small, curved, spreading claws between and beyond which projects a small, bilobed empodium. Leg III with coxa robust, about twice as long as broad, without vestiture; femur slightly more than one half as long as coxa, with one seta; genu one half as long as femur, slightly longer than broad, with three setae; tibia one and one-third times as long as genu, with four setae; tarsus as long as tibia, tapering from base to narrowly rounded apex, with three setae; tarsus surmounted by a slender pretarsus with imbricated margins, bearing at its apex two small, curved, spreading claws between and beyond which projects a small, bilobed empodium. Leg IV with coxa subquadrangular, robust, about twice as broad as long, with one ventral seta as long as segment; femur short and stout, one and one-third times as long as broad at base, inner and outer margins convex, one dorsal seta with length equal to basal width of segment, situated on a large tubercle near outer margin at about mid-segment, one ventral seta slightly shorter than dorsal seta, situated on a large tubercle near inner margin three fourths length of seta from apex of segment, one small ventral seta one half as long as the other ventral seta, situated on inner margin at about basal third of segment; tibia short and stout, nearly as broad as long, with one rodlike seta having length equal to one half basal width of segment, situated dorsally near outer margin at apical third, one short, stout, tactile seta, nearly as long as femur, situated near outer margin at apical fourth of segment; tarsus short, collarlike, one and one-half times as broad as long, with two short dorsal setae and one short ventral seta; tarsus subtends a large, curved, pointed claw having length equal to combined lengths of tibia and tarsus. *Genital papilla:* Large, subcordate, with anterior margin rounded and deeply emarginate mesially, posterior margin truncate; length, including projecting appendages, 25μ; greatest width, measured at anterior third, 23μ. *Anal plate:* Large and conspicuous; central disc with greatest dimension equal to the basal width of tarsus III, triradiate apodemes subequal in length, each as long as genu III. *Measurements:* Tips of palpi to apex of genital papilla, 139μ; anterior margin of propodosomal hood to apex of genital papilla, 117μ; anterior margin of hood to main body suture, 48μ; width of body immediately posterior to main body suture, 78μ.

Female: Body short and broadly oval, broadest at mid-length. Legs moderately short and stout, the second pair as long as but stouter than first pair; fourth pair very short, with their coxae well separated from each other and apices of fourth segments well separated from margins of body. Apodemes moderately strong, those of legs I two thirds as long as genu I, extending in posteromedial directions from innermost angles of coxae I converging medially. Apodemes II two thirds as long as tibiotarsus I, subparallel to apodemes I, extending from innermost condyles of coxae II to points the basal width of tibiotarsus I from median apodeme, their mesal terminations abrupt. Transverse apodeme strong and distinct, transecting body in a smooth, unbroken arc a short distance in front of main body suture, its lateral extremities the length of tibia II from margins of body. Anterior median apodeme extending forward from transverse apodeme for two thirds the distance from transverse apodeme to juncture of apodemes I, terminating abruptly at this point, posterior half of median apodeme not as distinct as anterior half of its length. Apodemes III short and broad, extending in nearly transverse directions from anterior condyles of coxae III for a distance equal to the length of femur III, their mesal extremities broad and fan-shaped. Apodemes IV short and weak, extending in anteromedial directions from points in transverse alignment with posterior thirds of coxae III, one half width of coxa III from their mesal margins, nearly to juncture with median apodeme but terminating indistinctly before such juncture. Posterior median apodeme extending from point in transverse alignment with anterior extremities of coxae IV to point the width of tarsus III behind main body suture, bifurcating at this anterior extremity with each arm extending for a short distance in an anterolateral direction, the apodeme strong and distinct only for the short part of its length situated between apodemes III. One obscure hysterosomal suture transects body dorsally at a point two fifths the distance from main body suture to apex of hysterosoma, this being in line with anterior thirds of coxae III. Three distinct sutures transect opisthosoma. Dorsum of propodosoma projected to form a broadly-rounded cephalothoracic hood which overhangs basal third of capitulum, the hood separated from remainder of dorsal propodosomal plate by a weak suture. Pseudostigmatic organs with their elongate, oval, expanded apices having a width equal to the length of slender pedicels. Stigmatal openings small, subcircular, situated dorsolaterally on propodosoma immediately posterior to suture forming posterior delimitation of cephalothoracic hood. *Dorsal chaetotaxy:* First pair of dorsal propodosomal setae quite long, length about equal to length of capitulum, situated posterolaterally on cephalothoracic hood; second pair of setae one and one-half times as long as first setae, located one third length of seta from main body suture, this distance from lateral margins of body. First pair of dorsal hysterosomal setae three fourths as long as first propodosomals, situated on lateral margins of body two thirds length of seta behind main body suture; setae of second pair equal in size to first setae; setae of third, fourth, fifth and sixth pairs short and subequal in length, two fifths as long as second setae. *Ventral chaetotaxy:* First pair of ventral propodosomal setae with length equal to basal width of tibiotarsus I, situated slightly behind apodemes I at mid-lengths of apodemes; second ventral propodosomals slightly longer than setae of first pair, located on apodemes II at their mid-lengths. First pair of ventral hysterosomal setae with length subequal to second ventral propodosomals, situated immediately mesad to mesal extremities of apodemes III; second ventral hysterosomal setae as long as setae of first pair, located at posterior extremities of apodemes IV; third pair of setae short, situated near apex of opisthosoma. *Capitulum:* Small, slender, subcordate with posterior margin rounded truncate and having a slight mesal emargination. Length, including projecting palpi, 29μ; greatest width, measured at posterior sixth of capsule, 22μ. Dorsal setae with length equal to one third width of capitulum and situated near anterolateral margins of capsule, separated from each other by a distance equal to length of seta. Ventral setae as long as dorsal setae, located near bases of palpi and separated from each other by a distance equal to two thirds length of seta. Palpi short and moderately robust, projecting a short distance beyond capitulum, indistinctly segmented and ornamented. Styliform chelicerae projecting between and slightly beyond apices of palpi; cheliceral sheaths without transverse striations. *Legs:* Leg I with coxa subquadrangular, as broad as long, without vestiture; femur one and one third times as long as broad, with two small dorsal setae, two long ventral setae; genu as broad at base as long, tapering slightly toward apex, with four setae; tibiotarsus twice as long as genu, about one third as broad at base as long, tapering slightly to broadly rounded apex, with one clavate, annulated seta having length equal to one half basal width of segment, situated middorsally on segment one half length of seta from base, one capitate, sensory seta as long as clavate seta, situated dorsally between clavate seta and outer margin of segment, one dorsal, spinelike seta slightly longer than capitate seta, located on lateral margin beside capitate seta, one large, clavate, annulated seta with length equal to three fourths basal width of segment, located dorsally near inner margin at about midsegment, one short, ventral, spurlike process projecting forward from inner apical margin of segment, eleven normal setae; tarsus surmounted by a short, broad pretarsus bearing at its apex a stout, curved claw and a small empodium. Leg II with coxa subquadrangular, slightly broader than long, without vestiture; femur short and stout, as broad at base as long, with three setae; genu broader than long, with three setae; tibia short and stout, as broad as long, with four setae; tarsus as long as tibia, as broad at base as long, tapering from base to narrowly rounded apex, with one clavate, annulated seta having length equal to one half basal width of segment, located dorsally on inner margin one half length of seta from base of segment, one very stout, spinelike seta with length equal to basal width of segment, located dorsally near inner margin at base, one stout spur having length equal to one half basal width of segment located ventrally near outer apical margin, four normal setae; tarsus surmounted by a very short, broad pretarsus subtending two strong, curved claws and a broad empodium. Leg

III with coxa slender, elongate, as long as combined lengths of genu, tibiotarsus and pretarsus I, one fourth as broad as long, without vestiture; femur two fifths as long as coxa, the basal two fifths of segment bulbous and separated from remainder of segment by an incomplete suture, the telofemur expanding from its base toward the broad apex and bearing two setae; tibia long and broad with its lateral margins slightly convex, length of segment equal to length of femur, with one very long ventral seta at basal third, one moderately long and two short setae at apical third of segment; tarsus slender, elongate, slightly shorter than tibia, with one short, stout spur situated ventrally near outer, apical margin, three normal setae; tarsus surmounted by a short, broad pretarsus with lateral margins appearing imbricated and bearing at its apex two large, curved, spreading claws beween and beyond which projects a broad empodium. Leg IV with coxa subtriangular, as broad as long, without vestiture; trochanter small, collarlike, broader than long, without setae; third segment relatively short, one and one eighth times as long as tibia II, with one ventral seta one half as long as segment situated near outer margin just before base of segment, one seta three fourths as long as segment, situated ventrally near outer margin just before apex; fourth segment about one third as long as third segment, with one stout ventral seta one and one half times as long as third segment, situated near mid-segment, one terminal seta twice as long as combined lengths of third and fourth segments. *Measurements:* Length of body from tips of palpi to apex of hysterosoma, 191μ; anterior margin of cephalothoracic hood to apex of hysterosoma, 122μ; anterior margin of hood to main body suture, 49μ; width of body at anterior condyles of coxae III, 102μ; distance between anterior condyles of coxae III, 52μ; distance between innermost margins of coxae IV, 10μ.

Types: Hoopes Bros. and Thomas Nursery, West Chester, Penn. Aug. 24-25, 1911, J. F. Zimmer, peach buds.

Location of types: U. S. National Museum (slide number 1122).

Material studied by the present writer included the type series as well as specimens identified by the following data: Bot. Dept., Mich. Agr. Coll., infesting fungus cultures (one male, several females); Avoncino-Mortensen Nursery, Colma, Calif., Nov. 15, 1949, R. E. Beer, fungus on agar plate culture of orchid seedlings (one male); Rockaway Beach, San Mateo Co., Calif., Dec. 13, 1949, R. E. Beer, mushroom house (one male, twenty females).

The above description of the male was made from the Colma, Calif. specimen; the description of the female given above was made from one of the Rockaway Beach series. The specimens in the original type series, so far as this writer could determine, are mounted on three slides, each slide identified by the same data and bearing the number Q6672. One slide contains a single male specimen, another a single female specimen and the third slide a single female and a badly shattered larva. Although the type series was studied by the present writer in the original balsam mounts, which have the specimens in a rather good state of preservation but poorly oriented on the slide, the composite picture of detailed characteristics of this species was surprisingly easy to derive, with subsequent identification of the Colma and Rockaway Beach series. Examination of the type slide containing the female and larva specimens reveals how Banks in his original characterization of the female of this species was led to mention as the most startling characteristic a series of long spines situated caudolaterally. In the specimen mentioned a slivering of the first opisthosomal segment has occurred which could easily be mistaken for spines. The male specimen in the above cotype series is hereby designated lectotype.

In life, mature adults of this species are pale amber in color, the dorsum of the females being greatly convex. The Rockaway Beach collection was made in a commercial mushroom house where the infestation was so severe that the surface of the casing soil in the benches actually had an amber rather than the natural black color. Under such conditions this species undoubtedly, through its fungivorous habits, is destructive to the crop being grown. As pointed out earlier in this paper, Banks' impression that *T. waitei* was destructive to terminal buds of peach trees was doubtless the incrimination of a guiltless trespasser.

Tarsonemus simplex Ewing

(Plates 13, 20 and 24)

Tarsonemus simplex Ewing, 1939, U. S. Dept. Agr. Tech. Bull., 653, p. 32.

Male: Body broad, oval, broadest at mid-length; legs of moderate length; apodemes distinct and well defined; genital papilla larger than capitulum; anal plate large and conspicuous. Apodemes I extending in posteromedial directions from inner angles of coxae I, converging medially at point in line with posterior margins of coxae I. Apodemes II twice as long as apodemes I and subparallel to the latter, extending from inner angles of coxae II to posterior extremity of anterior median apodeme. Anterior median apodeme extending from Y-shaped juncture of apodemes I to point slightly more than half distance to main body suture, this being point of convergence of apodemes II. Transverse apodeme moderately strong and conspicuous, transecting body in a smooth arc just anterior to main body suture. Posterior apodemes conspicuous. Apodemes III one and one-half times as long as coxae III, extending in anteromedial directions from anterior condyles of coxae III, curving inward rather abruptly at anterior third, converging with apodemes IV. Apodemes IV extending from outer basal angles of coxae IV to points the combined lengths of tibia and tarsus I behind main body suture, equidistant from median apodeme and apodemes III for their entire lengths, continuing in anteromedial directions from point of juncture with apodemes III for a distance equal to basal width of tarsus III, curving in posteromedial direction at this point and converging medially at anterior extremity of median apodeme. Posterior median apodeme extending from point of juncture of apodemes IV to point in line with anterior extremities of coxae IV, bifurcate at this point with forks extending to inner basal angles of coxae IV. Hysterosomal suture transecting body dorsally at posterior extremities of coxae III. Cephalothoracic shield with broadly truncate anterior margin longer than width of capitulum, projecting over basal fourth of capitulum. *Dorsal chaetotaxy:* Propodosoma with four pairs of dorsal setae; first pair as long as combined lengths of tibia and tarsus I, situated one half length of seta behind anterior margin of cephalothoracic shield, separated from each other by a distance equal to two thirds length of seta; second pair of setae two thirds as long as first pair, located the length of seta behind setae of first pair; third pair of setae one and one-half times as long as setae of first pair, located a distance equal to one third length of seta behind setae of second pair; fourth pair of setae as long as third pair, situated a distance equal to one third length of seta posterolaterad from setae of third pair. Hysterosoma with first pair of setae nearly as long as fourth pair of dorsal propodosomal setae, located one and one-fourth times length of seta behind main body suture, one third length of seta from lateral margins of body; second pair of setae as long as combined lengths of genu and tibia II, located near lateral margins of body, one half length of seta before hysterosomal suture; third pair of setae slightly shorter than second pair, located one half length of seta before hysterosomal suture at lateral margins of genital papilla; fourth pair of setae as long as third pair, located near lateral margins of body at apical third of genital papilla. *Ventral chaetotaxy:* Propodosoma with first pair of setae as long as basal width of tibia I, located one half length of seta posterolaterad from point of juncture of apodemes I; second pair of setae one and one-half times as long as setae of first pair, located one third length of seta behind apodemes II at their mid-lengths. Hysterosoma with first and second pairs of ventral setae located in interapodemal areas defined by apodemes III and IV; first pair as long as tibia III, located nearly on apodemes III at points the length of seta from juncture of apodemes III and IV; second pair of setae as long as first pair, situated nearly on apodemes IV, about twice length of seta from posterior extremities of apodemes. *Capitulum:* Subcordate, the posterior margin rounded truncate; length including projecting palpi, 28µ; greatest width, 21µ. Dorsal setae as long as genu I, located at apical fourth of capitulum, separated from each other by a distance equal to one and one-fourth times length of seta. Ventral setae as long as dorsal setae, separated from each other by a distance slightly less than length of seta. Palpi stout, indistinctly segmented, projecting beyond apex of capitulum. Chelicerae short, needlelike; cheliceral sheaths prominent, without transverse or spiral striae. *Legs:* Anterior pairs of moderate length, slightly longer than propodosoma, legs I slightly longer than legs II. Leg I with coxa subquadrangular, one and one-half times as broad as long, with width equal to combined lengths of genu and tibia I, without vestiture; femur as long as width of coxa, with two normal setae; genu slightly more than one half as long as femur, slightly broader than long, with four setae; tibia one and one-third times as long as genu, the lateral margins subparallel for most of their lengths, with one clavate, annulated seta having length equal to one third basal width of segment, located near outer margin the length of seta from base of segment, one capitate seta with length equal to one half basal width of segment located on outer margin at basal third, five normal setae; tarsus one and one-fourth times as long as tibia, nearly three times as long as broad at base, tapering slightly to broadly rounded apex, with one clavate, annulated seta as long as basal width of segment located near outer margin at base, five normal setae; tarsus surmounted by a narrow pretarsus with length equal to apical width of tarsus, bearing at its apex a single, stout, curved claw projecting beyond a small empodium. Leg II with coxa subquadrangular, nearly twice as broad as long, without vestiture; femur as long as combined lengths of genu and tibia, outer margin twice as long as inner margin, with one seta; genu one half as long as femur, one and one-half times as broad as long, with three setae; tibia slightly longer than genu, slightly broader than long, lateral margins subparallel, segment with four setae; tarsus as long as combined lengths of genu and tibia, about two and one-half times as long as broad at base, tapering abruptly to narrowly rounded apex, with one very large, broadly lanceolate, annulated seta having length equal to basal width of segment, one half as broad as long, situated dorsally near inner margin at base, four normal setae; tarsus surmounted by a narrow pretarsus, about one fourth as long as tarsus, bearing at its apex two strong, curved, spreading claws between and beyond which projects a broad empodium. Leg III with coxa as long as combined lengths of genu, tibia, and tarsus of leg II, slightly more than twice as long as broad, with anterior extremity acute, segment without vestiture; femur two thirds as long as coxa, with basal half expanded bulbous, with one dorsal seta; genu as long as tibia II, as broad as long, expanded slightly toward apex, with three normal setae; tibia one and one-half times as long as genu, nearly twice as long as broad at base, with lateral margins parallel for most of their lengths, segment with four normal setae; tarsus as long as tibia, two and one-half times as long as broad at base, tapering to broadly rounded apex, with three setae; tarsus surmounted by a narrow pretarsus, nearly one half as long as tarsus, bearing distally two curved, spreading claws between and beyond which projects a broad empodium. Leg IV with short, subquadrangular coxa nearly twice as broad as long, width equal to combined lengths of tibia and tarsus I, with one ventral seta as long as segment located near outer margin at about mid-segment; femur short and broad, length equal to combined lengths of genu, tibia, and tarsus III, greatest width slightly more than half length of segment, the outer margin uniformly convex, inner margin straight for most of its length but gently incurved at base, segment with one dorsal seta two thirds as long as segment located one third the distance from outer to inner margin at apical third of segment, one ventral seta nearly as long as segment located near inner margin at apical third, one ventral seta one half as long as dorsal seta located near inner margin slightly basad from mid-segment; tibia as long as apical width of femur, with one dorsal, peglike, annulated seta having length equal to basal width of segment, located near outer margin at apical third, one elongate, tactile seta, as long as leg IV, located ventrally near outer margin at apex; tarsus very small, one fourth as long as tibia, three times as broad as long, with one seta as long as width of segment located dorsally on inner margin at mid-segment, one ventral seta as long as width of segment situated on inner margin at mid-segment, one short seta on outer margin at mid-segment; tarsus surmounted by a large, curved claw, nearly as long as combined lengths of tibia and tarsus, with width at base equal to one third its length. *Genital papilla:* Length, 26μ; width 24μ; subcordate, with anterior margin emarginate, posterior margin broadly truncate, bearing two short, caudolateral, projecting horns. *Anal plate:* Large and well-defined, with diameter of central disc equal to one half width of tibia II; triradiate apodemes each as long as tibia I with expanse of plate equal to combined lengths of genu and tibia II. *Measurements:* Length from tip of capitulum to apex of genital papilla, 136μ; main body suture to apex of genital papilla, 79μ; anterior margin of cephalothoracic shield to main body suture, 39μ; width of body at main body suture, 66μ; width at anterior extremities of coxae III, 76μ.

Female: Body broad, oval, broadest at posterior extremities of coxae III. Legs short and stout, the anterior pairs rather widely separated from posterior pairs; legs III separated from each other at nearest point by a distance equal to distance from posterior extremity of coxa III to lateral margin of body; inner angles of coxae IV separated from each other by a distance equal to three fourths length of third segment of leg IV. Apodemes inconspicuous and not clearly defined, those of legs I converging medially slightly behind anterior extremity of ventral plate. Apodemes II very faint, length equal to twice length of tibia II, extending from inner angles of coxae II in posteromedial direction terminating at point the length of apodeme before main body suture and one half length of apodeme from mid-body. Anterior median apodeme visible as a faint broken line extending from juncture of apodemes I almost to main body suture. Transverse apodeme apparently absent. Posterior apodemes reduced, those of legs III extending in nearly cephalic directions from anterior condyles of coxae III for a distance equal to one fourth greatest width of coxa III, curving abruptly in anteromedial direction at this point and continuing for distance equal to width of coxa III, the posterior fourth of apodemes distinct, remaining portions very faint; apodemes IV indistinct. Posterior median apodeme as long as tibia II. First hysterosomal suture well defined, transecting body the length of tarsus II behind main body suture. Two well-defined transverse sutures on opisthosoma. Dorsum of propodosoma projected to form a cephalothoracic shield which extends over basal half of capitulum, its truncate anterior margin with dimension equal to two thirds greatest breadth of capitulum. Pseudostigmatic organs as long as tibiotarsus I, the expanded apex elongate-oval as long as narrow pedicel and one and one-half times as long as greatest breadth. Stigmatal openings distinct, diameter about equal to one third greatest width of expanded apex of pseudostigmatic organs, located in line with basal fifth of capitulum one fourth width of capitulum laterad from margin of capitulum. *Dorsal chaetotaxy:* Propodosoma with first pair of setae having length equal to two thirds greatest width of capitulum, located near margin two thirds length of seta behind anterolateral angles of propodosoma; second pair with length equal to width of capitulum, situated immediately behind areoli of pseudostigmatic organs. Hysterosoma with first pair of setae as long as tibiotarsus I, located on lateral margins of body one half length of seta behind main body suture; second pair of setae two thirds as long as setae of first pair, located three fourths length of seta in front of and slightly laterad from anterior condyles of coxae III; setae of third pair as long as those of second pair, located twice length of seta behind posterolateral angles of coxae III; fourth pair of setae with length equal to greatest width of femur III, located near lateral margins of body the length of seta in front of last hysterosomal suture; setae of fifth pair subequal in length to setae of fourth pair, located one half length of seta before last hysterosomal suture and separated from each other by a distance equal to twice length of seta; sixth pair of setae slightly longer than setae of fifth pair, situated on lateral margins of apical segment of hysterosoma and separated from each other by a distance equal to twice length of seta. *Ventral chaetotaxy:* Propodosoma with first pair of setae having length equal to width of genu I, located one half length of seta behind anterior margin of ventral plate, separated from each other by a distance equal to one and one-half times length of seta; second pair of setae one and one-half times as long as setae of first pair, situated slightly behind apodemes II at about their mid-lengths. Hysterosoma with first pair of setae having length equal to width of tibia II, situated one third length of seta behind first hysterosomal suture, separated from each other by a distance equal to three and one-half times length of seta; second pair of setae subequal in length to first pair, located the length of seta mesad from inner margins of coxae III slightly posterior to their mid-lengths; third pair of setae slightly shorter than setae of second pair, located at apex of hysterosoma and separated from each other by a distance equal to slightly more than twice length of seta. *Capitulum:* Subcordate, the posterior margin truncate; length including projecting palpi, 33μ; width, 27μ. Dorsal setae short, their length equal to basal width of tibiotarsus I, located in line with bases of palpi and one half length of seta from lateral margins of capitulum, separated from each other by a distance equal to one and one-half times length of seta. Ventral setae slightly shorter than dorsal setae, located in line with latter. Palpi short and broad, their lengths equal to length of tibia II, width nearly one half length, the palpal bases inserted on apical fifth of capitulum. Chelicerae needlelike, projecting forward as far as palpi; cheliceral sheaths not striate. *Legs:* Anterior pairs short and broad. Leg I with coxa subtriangular, nearly one and one-half times as broad as long, without vestiture; femur with length equal to two thirds greatest width of capitulum, one and one-fourth times as long as greatest breadth, tapering slightly from base to apex, with four normal setae; genu, two thirds as long as femur, slightly longer than broad at base, with four setae; tibiotarsus about twice as long as genu, tapering slightly to broadly rounded apex, with one lanceolate, annulated seta having length equal to two thirds basal width of segment located dorsally on inner margin just before mid-segment, eleven normal setae; tarsus surmounted by a short pretarsus, with length equal to two thirds basal width of tarsus and bearing subapically a stout, curved claw and a small empodium. Leg II with coxa subtriangular, one and one-half times as broad as long, without vestiture; femur as long as femur I, nearly as broad at base as long, tapering slightly to apex, with two setae; genu one half as long as femur, one and one-half times as broad as long, with three setae; tibia slightly longer than genu, as broad as long, outer margin strongly convex, with four setae; tarsus as long as tibia, tapering abruptly from base to narrowly rounded apex, with one clavate seta having length equal to one half width of tibia, located near inner margin at base, three normal setae; tarsus surmounted by a short pretarsus with length equal to one half basal width of tarsus, bearing at its apex two stout, curved, spreading claws between and beyond which projects a broad empodium. Leg III with coxa narrow, as long as combined lengths of three distal segments of leg II, nearly four times as long as broad, without vestiture; femur one half as long as coxa, the outer margin indented at about mid-length, with basal half of segment expanded bulbous, lateral margins divergent from mid-length to apex, width at apex equal to two fifths length of segment, bearing two setae; tibia as long as tibiotarsus I, two and one-half times as long as greatest breadth, tapered slightly from mid-length to apex, with four setae; tarsus narrow, elongate, with length equal to three fourths length of tibia, sides subparallel for most of their lengths, with three setae; tarsus surmounted by a short pretarsus with length equal to basal width of tarsus, bearing at its apex two spreading, curved claws between and beyond which projects a broad empodium. Leg IV with coxa collarlike, more than twice as broad as long, without vestiture, inner margins of coxae separated from each other by a distance slightly less than combined widths of segments; trochanter small, ringlike, broader than long, without setae; third segment rodlike, as long as tibia III, with one ventral seta one fourth as long as segment located on outer margin near base, one ventral seta one third as long as segment located on outer margin at about apical third of segment; fourth segment about two fifths as long as third segment and three times as long as broad at base, expanding slightly toward apex, with one subapical, ventral seta nearly as long as third segment located near outer margin at apical third, one terminal seta nearly one and one-half times as long as leg IV. *Measurements:* Tips of palpi to apex of opisthosoma, 191μ; apex of cephalothoracic shield to tip of opisthosoma, 175μ; tip of shield to main body suture, 48μ; width at main body suture, 72μ; width at anterior condyles of coxae III, 92μ; distance between anterior condyles of coxae III, 49μ.

Types: One male and twelve females mounted on one slide, three females on a second slide, both slides identified with the following data: Mass., 1929, Dr. Plakidas, on *Fragaria* sp. The male specimen is hereby designated lectotype.

Location of types: Two slides in U. S. National Museum, numbered 1128.

In addition to the type series, the present author examined specimens which were recognized as this species and which are identified by the following data: Univ. of Wisc., Plant Path. Lab., infesting fungus cultures (one male and three females); U. C. Botany Dept. greenhouse, Berkeley, Calif., Aug. 16, 1949, R. E. Beer, agar culture of fungus (six males and three females); K. U. Ent. Lab., Lawrence, Kans., Apr. 10, 1953, R. E. Beer, from cockroach rearing cage (two males and two females).

The above descriptions of both sexes were made from specimens of the Berkeley series.

This species very closely resembles *T. pritchardi*, *T. confusus* and *T. waitei.* The tactile seta of tibia IV in the male is quite long, which distinguishes this species from both *T. confusus* and *T. waitei*, both of which have relatively short tactile setae. The long claw of the male leg IV further distinguishes this species from *T. confusus* as well as from *T. pritchardi*, both of which have relatively short claws.

Tarsonemus texanus Ewing

(Plates 14, 20 and 24)

Tarsonemus texanus Ewing, 1939, U. S. Dept. Agr. Tech. Bull., 653, p. 31.

Male: Body broadly oval, broadest at anterior condyles of coxae III; legs relatively short and robust, the anterior pair slightly longer but not as stout as legs II, legs IV short and very stout; apodemes strong and well defined; genital papilla large; anal plate large and distinct. Apodemes I as long as genu I, extending in posteromedial directions from innermost angles of coxae I, converging to form a Y-shaped juncture with anterior extremity of median apodeme. Apodemes II about one and one-half times as long as apodemes I, extending in posteromedial directions from innermost angles of coxae II, curving abruptly forward just before juncture. Transverse apodeme absent. Anterior median apodeme strong and conspicuous, extending uninterrupted between junctures of apodemes I and II. Apodemes III about twice as long as apodemes II, extending in anteromedial directions from anterior extremities of coxae III, curving inward in smooth arcs and intersecting apodemes IV at points length of tarsus II behind main body suture. Apodemes IV subparallel to apodemes III for most of their lengths, extending from outer basal angles of coxae IV to juncture with apodemes III, here curving inward to unite medially at a point two thirds the length of tarsus II behind main body suture. Posterior median apodeme extending from point slightly caudad from juncture of apodemes IV to point nearly in transverse alignment with posterior extremities of apodemes IV, the apodeme strongest in anterior two fifths of its length. Anterior margin of propodosomal dorsal shield broadly and angularly truncate and projecting as a hood over basal fifth of capitulum. *Dorsal chaetotaxy:* First pair of dorsal propodosomal setae nearly as long as combined lengths of genu, tibia and tarsus II, situated at points two thirds the length of seta behind anterolateral angles of hood, the setae separated from each other by a distance equal to one half the length of seta; second dorsal propodosomals two thirds as long as setae of first pair, located behind and slightly laterad from first setae a distance slightly less than length of setae; third pair of setae twice as long as setae of second pair, situated behind and slightly laterad from second setae a distance equal to one third the distance separating the first and second setae; fourth pair of dorsal propodosomal setae slightly longer than setae of second pair, situated laterad from and slightly behind third setae a distance equal to one and one-half times the distance separating second and third setae. First pair of dorsal hysterosomal setae longer than the others and slightly shorter than first dorsal propodosomals; third dorsal hysterosomal setae shorter than the others and slightly shorter than second dorsal propodosomals. *Ventral chaetotaxy:* First pair of ventral propodosomal setae as long as genu I, situated slightly laterad from juncture of apodemes I; second ventral propodosomals as long as setae of first pair, situated two thirds length of seta behind apodemes II at about mid-lengths of apodemes. First ventral hysterosomals slightly longer than ventral propodosomal setae, located slightly behind apodemes III at about anterior two fifths of apodemes; second ventral hysterosomals slightly longer than setae of first pair, located slightly laterad from apodemes IV at posterior fourths of apodemes. *Capitulum:* Small, subcordate, with posterior margin rounded truncate; length, including projecting palpi, 30μ; greatest width, measured at posterior third, 22μ. Dorsal setae as long as tarsus I, situated near anterolateral extremities of capsule. Ventral setae two thirds as long as dorsal setae, located near bases of palpi and separated from each other by a distance equal to length of seta. Palpi relatively short and of moderate robustness, projecting a short distance beyond apex of capsule. Styliform chelicerae projecting between but not beyond palpi; cheliceral sheaths without striae. *Legs:* Leg I with coxa subquadrangular, about as broad as long, without vestiture; femur short and stout, as broad at base as long, with three setae; genu broader than long, with three setae; tibia slightly longer than broad, with one small, clavate seta having length equal to one third basal width of segment, located mid-dorsally the length of seta from base of segment, one slender, rodlike seta more than twice as long as clavate seta, situated dorsally near outer margin one half length of seta from base of segment, one capitate seta slightly shorter than rodlike seta, located between the latter and the clavate seta, five normal setae; tarsus one and one-half times as long as tibia, lateral margins converging slightly toward broad apex, segment with one short, clavate, annulated seta as long as basal width of segment, located dorsally near outer basal margin, seven normal setae; tarsus surmounted by a short, slender pretarsus which subtends a small, curved claw. Leg II with coxa subquadrangular, broader than long, without vestiture; femur short and stout, as broad at base as long, with three setae; genu broader than long, with three setae; tibia as broad at base as long, with four setae; tarsus nearly twice as long as tibia, tapering from broad base to slender apex, with one large, lanceolate, annulated seta, two thirds as long as segment, located dorsally near outer basal margin, four normal setae; tarsus surmounted by a short, slender pretarsus which subtends two small, curved, spreading claws between which projects a small empodium. Leg III with coxa of moderate length, greatest width about one half length of segment, without vestiture; femur about one half as long as coxa and about one half as broad as long, with three setae; tibia one and one-third times as long as broad, with four setae; tarsus slightly longer than tibia, tapering from base to broadly rounded apex, with three setae; tarsus surmounted by a short, slender pretarsus which subtends two small, curved, spreading claws between and beyond which projects a small, bilobed empodium. Leg IV with coxa large and subquadrangular, about one and one-third times as broad as long, with one ventral seta; femur robust, nearly two thirds as broad at base as long and one third as broad at apex as long, with one dorsal seta two thirds as long as segment, located near outer margin at apical third, one ventral seta as long as dorsal seta, situated near mid-segment at apical third, one ventral seta as long as apical width of segment, located near inner margin at basal two fifths; tibia short and stout, as broad at base as long, with one rodlike seta having length nearly equal to apical width of segment, situated dorsally near outer margin at apical third, one tactile seta longer than entire leg, situated ventrally near outer margin at apical third; tarsus twice as broad as long, with two small dorsal setae and one ventral seta; tarsus subtends a large, strong, curved claw with length equal to length of tibia. *Genital papilla:* Large and subcordate, with anterior margin emarginate, posterior margin broadly truncate; length, 26μ; greatest width, measured at anterior fifth, 26μ. *Anal plate:* Large and well-defined, its triradiate apodemes extending a distance equal to one half the width of genital papilla; central disc situated ventrally the length of genu I anterior to anterior margin of genital papilla. *Measurements:* Length of body from tips of palpi to apex of genital papilla, 141μ; anterior margin of cephalothoracic hood to apex of genital papilla, 126μ; anterior margin of hood to main body suture, 47μ; width of body at main body suture, 84μ; width at anterior condyles of coxae III, 89μ.

Female: Body broadly oval, broadest at posterior extremities of coxae III. Legs relatively short and stout, the anterior pairs subequal in size and widely separated from posterior pairs; innermost margins of coxae IV separated from each other by a distance equal to length of coxa IV. Apodemes indistinct, those of legs I as long as basal width of tibiotarsus I, extending in nearly transverse directions from innermost angles of coxae I and joining at mid-body. Apodemes II about twice as long as apodemes I, extending in posteromedial directions from innermost angles of coxae II and converging medially at a point midway between point of convergence of apodemes I and main body suture. Transverse apodeme apparently absent. Anterior median apodeme extending from point of convergence of apodemes I nearly to main body suture, distinct only in posterior half of its length. Apodemes of hysterosoma not clearly defined. Dorsal segmentation of hysterosoma distinct, with one well-defined suture transecting body in the region of coxae IV, three transverse sutures in opisthosoma. Dorsal plate of propodosoma projected forward to form a hood which covers posterior two thirds of capitulum, the anterior margin of hood truncate and with dimension slightly less than width of capitulum. Pseudostigmatic organs nearly as long as tibiotarsus I, with expanded apices elongate oval and about twice as long as slender pedicels. Stigmatal openings large and conspicuous, situated dorsolaterally midway between pseudostigmatic organs and anterolateral angles of hood. *Dorsal chaetotaxy:* First pair of dorsal propodosomal setae as long as tibiotarsus I, situated one third length of seta behind anterolateral angles of cephalothoracic hood; second pair of setae one and one-third times as long as setae of first pair, located the length of seta anterior to main body suture and one third this distance from lateral margins of body. First and second dorsal hysterosomal setae subequal in size, slightly shorter than first dorsal propodosomals; third, fourth, fifth and sixth pairs of setae about equal in size, one half as long as first dorsal propodosomals. *Ventral chaetotaxy:* First pair of ventral propodosomal setae nearly as long as genu I, situated one half length of seta behind apodemes I at about mid-lengths of apodemes; second ventral propodosomals one and one-half times as long as setae of first pair, located near centers of areas delimited by apodemes II, median apodeme, main body suture and inner bases of coxae II. First ventral hysterosomals as long as first ventral propodosomals, located at points three times length of seta behind main body suture and separated from each other by about this distance; second ventral hysterosomals about as long as setae of first pair, located one and one-half times length of seta anterior to outer basal angles of coxae IV; third pair of setae short, situated at apex of opisthosoma and separated by a distance equal to their combined lengths. *Capitulum:* Relatively small and subcordate, with posterior margin rounded truncate; length, including projecting palpi, 34µ;

greatest width, measured at posterior third, 26μ. Dorsal setae as long as genu I, located near anterolateral angles of capsule. Ventral setae as long as dorsal setae, situated near bases of palpi and separated from each other by a distance equal to length of seta. Palpi short and slender, projecting slightly beyond apex of capitulum, indistinctly segmented and ornamented. Styliform chelicerae projecting between and slightly beyond apices of palpi; cheliceral sheaths without striae. *Legs:* Leg I with coxa subquadrangular, nearly as broad as long, without vestiture; femur slightly longer than broad at base, with two long ventral setae and two short dorsal setae; genu as broad at base as long, with three setae; tibiotarsus three times as long as broad at base, tapering slightly from base to broadly rounded apex, with one small, clavate seta having length equal to one third basal width of segment, situated middorsally one half length of seta from base of segment, one rodlike seta, one and one-half times as long as clavate seta, situated dorsally near inner margin one half length of seta from base of segment, one capitate seta nearly as long as rodlike seta, situated between the latter and the clavate seta, one large, clavate, annulated seta having length slightly less than basal width of segment, located dorsally near outer margin at about basal third of segment, one long, tactile seta, longer than segment, situated dorsally near outer basal margin, twelve normal setae; tarsus surmounted by a short pretarsus which subtends a strong, curved claw and a small empodium. Leg II with coxa subquadrangular, slightly broader than long, without vestiture; femur robust, as broad as long, with three setae; genu broader than long, with three setae; tibia as broad as long, with four setae; tarsus twice as long as broad at base, tapering abruptly from base to narrowly rounded apex, with one clavate, annulated seta having length nearly equal to basal width of segment, located dorsally near inner basal margin of segment, five normal setae; tarsus surmounted by a short pretarsus having imbricated lateral margins and subtending a pair of strong, curved, spreading claws between and beyond which projects a large empodium. Leg III with coxa elongate, oval, one half as broad as long, without vestiture; femur one half as long as coxa, with constriction and incomplete suture at basal two fifths of segment separating the subglobose basifemur from the telofemur, the latter with lateral margins diverging from its base to its broad apex, telofemur with three setae; tibia as long as femur, twice as long as broad at base, with four setae; tarsus slender, elongate, nearly as long as tibia, with three setae; tarsus surmounted by a short, slender pretarsus which bears at its apex two large, curved, spreading claws between and beyond which projects a broad empodium. Leg IV with coxa subquadrangular, as broad as long, without vestiture; trochanter collarlike, broader than long, without vestiture; third segment relatively short, as long as femur III, with one ventral seta two fifths as long as segment, situated near outer margin at base of segment, one seta one half as long as segment, located ventrally near outer margin at apical third; fourth segment one third as long as third segment, its apex extending to point the length of segment before margin of body, with one stout, ventral seta as long as third segment, located near outer margin at apical two fifths, one terminal seta as long as leg IV. *Measurements:* Length of body, from tips of palpi to apex of hysterosoma, 174μ; anterior margin of cephalothoracic hood to apex of hysterosoma, 157μ; anterior margin of hood to main body suture, 40μ; width of body at main body suture, 77μ; width of body at anterior condyles of coxae III, 43μ; distance between innermost margins of coxae IV, 9μ.

Types: Brownsville, Texas, Nov. 9, 1933, F. H. Benjamin, on date palm leaves.

Location of types: U. S. National Museum, two slides numbered U.S.N.M. 1127.

Additional specimens included in this study by the present author are identified with the following data: U. C. Botany Dept., Berkeley, Calif., Nov. 3, 1949, R. E. Beer, in fungus cultures (three males, one female); U. C. campus, Berkeley, Calif., July 8, 1949, R. E. Beer, in association with *Hemiberlesia rapax* infesting *Ilex aquifolium* (one male, four females); St. Marys, Ga., Nov. 11, 1937, E. V. Komarek, on *Geomys colonus* (one male, one female).

The above redescriptions were made from specimens from the Berkeley fungus culture collection. The type series is represented by three males and ten females on one slide, with most of the females and one of the males broken or missing parts, and one male and seven females on a second slide. Measurements of the single male (encircled, apparently by Ewing) on the second slide were made by the present writer and are here included: Length of body, from tips of palpi to apex of genital papilla, 134μ; tips of palpi to main body suture, 60μ; width of body just behind main body suture 90μ; capitulum, 30μ long, 24μ wide; genital papilla, 24μ long, 26μ wide. This specimen is hereby designated lectotype.

In the male, this species is similar to *T. pritchardi* and *T. simplex* in having the tactile seta of tibia IV very long. However, the long dorsal and ventral setae of femur IV and the long claw of leg IV as well as the placement of the second ventral hysterosomal setae distinguish *T. texanus* from these closely related species.

Tarsonemus pritchardi, new species

(Plates 13, 20 and 24)

Male: Body broad, oval, broadest slightly behind main body suture. Apodemes conspicuous and well defined. Apodemes I as long as tibia II, extending from innermost angles of coxae I to anterior extremity of median apodeme, converging with the latter and forming a right angle with one another. Apodemes II twice as long as apodemes I, extending posteromedially from inner angles of coxae II to median apodeme, intersecting latter at a point slightly more than half the distance from anterior extremity of median apodeme to main body suture. Anterior median apodeme as long as combined lengths of genu and tibia II, extending from Y-shaped juncture of apodemes I to point of intersection of apodemes II. Transverse apodeme apparently absent. Apodemes III with posterior portion distinct, extending anteromedially from anterior extremities of coxae III a distance equal to four fifths length of coxa III, curving in transverse direction at this point, indistinctly continuing to juncture with apodemes IV. Apodemes IV extending anteromedially from outer basal angles of coxae IV, converging slightly on apodemes III, to point the length of anterior median apodeme behind main body suture, separated from posterior median apodeme at this point by a distance equal to the length of tibia II, apodemes indistinctly curving in transverse direction here, continuing to intersection with median apodeme. Posterior median apodeme conspicuous, extending from point in line with anterior extremities of coxae IV to a point the length of anterior median apodeme behind main body suture. Anterior margin of propodosoma not extended to form a cephalothoracic shield. *Dorsal chaetotaxy:* Propodosoma with first pair of setae as long as combined lengths of genu and tibia I, located one third length of seta behind anterior margin of propodosoma, separated from each other by a distance equal to two thirds length of seta; second pair of setae one half as long as first pair, situated the length of seta behind and slightly laterad from setae of first pair; third pair of setae one and one-fourth times as long as first pair, located a distance slightly less than length of second seta behind and slightly laterad from setae of second pair; fourth pair of setae as long as first pair, located a distance the length of second seta behind and slightly laterad from setae of third pair, this position being one half length of seta from main body suture. Hysterosoma with first pair of setae as long as fourth pair of propodosomal setae, situated on lateral margins of body midway between anterior extremities of coxae III and main body suture; second pair of setae two thirds as long as setae of first pair, located near lateral margins of body in line with anterior extremities of coxae IV; third pair of setae subequal in length to setae of second pair, located nearly in transverse line with setae of second pair, separated from each other by a distance equal to their combined lengths; fourth pair of setae as long as third pair, located near caudolateral margins of body immediately beside genital papilla at its anterior fourth. *Ventral chaetotaxy:* Propodosoma with first pair of setae as long as genu II, located one half length of seta laterad from juncture of apodemes I; second pair of setae twice as long as setae of first pair, situated one fourth length of seta behind apodemes II at their mid-lengths, the length of seta from main body suture. Hysterosoma with first pair of setae one and one-half times as long as genu II, located one third the distance from apodeme III to apodeme IV at their conspicuous anterior extremities; second pair of setae slightly longer than first pair, situated in same interapodemal areas as first pair, very close to apodemes IV at their posterior thirds. *Capitulum:* Large, subcordate, posterior margin rounded, truncate, length including projecting palpi, 28μ; greatest width, 22μ. Dorsal setae with length equal to basal width of tarsus I, situated near apex of capitulum, separated from each other by a distance equal to one and one-half times length of seta. Ventral setae as long as genu I, situated nearly opposite dorsal setae, separated from each other by a distance equal to length of seta. Palpi short, stout, indistinctly segmented, projecting a short distance beyond apex of capitulum. Chelicerae short, needlelike, projecting forward between palpi as far as tips of latter; cheliceral sheaths conspicuous, without transverse striae. *Legs:* Anterior pairs of moderate length, legs I slightly longer than legs II. Leg I with coxa subquadrangular, one and one-half times as broad as long, without setae; femur with length equal to one half greatest width of capitulum, tapering from base toward apex, with three normal setae; genu three fifths as long as femur, about as broad as long, with four setae; tibia one and one-half times as long as genu, one and one-half times as long as broad at base, tapering slightly toward apex, with one short, ovate, annulated seta with length equal to one half basal width of segment located mid-dorsally one half length of seta from base, one slender, capitate seta slightly longer than ovate seta situated between latter and outer margin of segment, one rodlike seta with length equal to two thirds basal width of segment situated near outer margin at basal third, one tactile seta nearly twice as long as segment located middorsally slightly distad from mid-segment, four normal setae; tarsus slightly longer than tibia, nearly three times as long as broad at base, tapering to broadly rounded apex, with one short, ovate, annulated seta with length equal to three fourths basal width of segment situated middorsally at base, six normal setae; tarsus surmounted by a very short pretarsus bearing a small, curved claw, the tip of which projects beyond a broad, subcircular empodium. Leg II with coxa subquadrangular, one and one-fourth times as broad as long, without vestiture; femur as long as femur I, slightly broader than latter, with three setae; genu slightly shorter than genu I, slightly broader than long, lateral margins tapering a little from base to apex, with three setae; tibia slightly longer than genu, slightly longer than broad at base, with four normal setae; tarsus one and two-thirds times as long as tibia, two and one-half times as long as broad at base, tapering from base to narrowly rounded apex, with one very large, ovate, annulated seta with length equal to three fifths length of segment and greatest width one third its length, located middorsally at base of segment, one short, ventral, peglike seta with length equal to one half basal width of segment, located near inner margin at apex, three normal setae; tarsus surmounted by narrow pretarsus with length equal to basal width of tarsus, bearing at its apex two small, curved claws between and beyond which extends a broad, bilobed empodium. Leg III with coxa subtriangular, length equal to combined lengths of tibia and tarsus I, greatest width equal to two fifths length, without setae; femur as long as tarsus I, outer margin indented at mid-segment, basal half expanded bulbous, distal half of segment expanding slightly toward apex, with one dorsal seta; genu one half as long as femur, slightly longer than broad, sides subparallel, with three setae; tibia one and one-half times as long as genu, nearly twice as long as width at base, lateral margins subparallel, with four setae; tarsus as long as tibia, two and one-half times as long as broad at base, tapering from base to broadly rounded apex, with four normal setae; tarsus transcended by narrow pretarsus as long as basal width of tarsus, bearing at its apex two small, spreading, curved claws between and beyond which projects a broad empodium. Leg IV with coxa subtriangular, outer margin three times as long as inner margin, width of segment equal to combined lengths of genu and tibia III, length of outer margin equal to two thirds width of segment, with one ventral seta as long as segment situated one third length of seta from outer margin at about mid-length of segment; femur twice as long as coxa, outer margin slightly convex, inner margin expanded slightly at basal third, width of segment at apex equal to one half width at base, segment with one dorsal seta one half as long as segment located on large tubercle near outer margin at apical third, one ventral seta with length equal to apical width of segment situated near inner margin at mid-segment, one seta with length equal to length of outer margin of segment located mid-ventrally at apical third; tibia and tarsus ankylosed forming a tibiotarsus with a short, indistinct vestige of a suture at apical fourth of segment, length of segment equal to apical width of femur, outer margin slightly convex, inner margin concave, with one short, narrow, ovate, annulated seta with length equal to one third basal width of segment situated dorsally near outer margin slightly distad from mid-segment, one dorsal seta having length equal to one third basal width of segment located on inner margin at apex, one stout tactile seta two and one-half times as long as segment situated ventrally near outer margin at apical third, one seta with length equal to two fifths basal width of segment located ventrally on inner margin at apical fourth; tibiotarsus terminating in a stout, curved claw with length equal to three fourths basal width of tibiotarsus, about twice as long as broad at base. *Genital papilla:* Length, 22μ; width, 23μ; subcordate, with anterior margin emarginate, posterior margin broadly truncate and with two short caudolaterally projecting horns. *Measurements:* Length from tip of capitulum to apex of genital papilla, 136μ; main body suture to apex of genital papilla, 74μ; anterior margin of propodosoma to main body suture, 38μ; width at main body suture, 65μ; width at anterior extremities of coxae III, 67μ.

Female: Body broadly oval, broadest at mid-length, lateral margins subparallel between legs II and III. Anterior pairs of legs short and stout, legs II immediately adjacent to legs I, these widely separated from posterior pairs. Apodemes inconspicuous, those of legs I indistinctly converging medially just behind anterior extremity of ventral plate, the latter clearly delimited by an unbroken undulating line extending from hind margins of coxae II to mid-body immediately behind capitulum. Apodemes II indistinct, extending in posteromedial directions from inner angles of coxae II a distance equal to length of femur II terminating two fifths length of apodeme from median apodeme. Anterior median apodeme visible as a broken line, extending from point just behind intersection of apodemes I to main body suture. Transverse apodeme apparently absent. Apodemes III barely visible, extending in anteromedial directions from anterior extremities of coxae III a distance equal to one third length of coxa III. Apodemes IV indistinct. Posterior median apodeme visible as a faint broken line, extending medially from point in line with posterior thirds of coxae III to point the width of coxa III behind main body suture, bifurcate a short distance before anterior extremity. Three transverse hysterosomal body sutures distinct dorsally, one transecting body at posterior extremities of coxae III, one at a point one fifth the distance from coxae IV to apex of opisthosoma, one at apical fifth of opisthosoma. Propodosoma extended dorsally forming a broadly rounded cephalothoracic shield which projects anteriorly over basal two thirds of capitulum, posterolateral extremity of shield at stigmatal openings, lateral margins of body expanding at these points. Pseudostigmatic organs shorter than tibiotarsus I, about as long as combined lengths of genu and tibia II; expanded apex elongate oval, one and one-fourth times as long as narrow pedicel, nearly twice as long as greatest width; areoli conspicuous, diameter equal to three fourths width of expanded apex of organ. Stigmatal openings distinct as heavily sclerotized rings with diameter equal to one half diameter of areolus of pseudostigmatic organ, situated two thirds length of pseudostigmatic organs in front of and slightly medial to same, openings separated from each other by a distance equal to one and one-third times greatest width of capitulum. *Dorsal chaetotaxy:* Propodosoma with first pair of setae as long as tibiotarsus I, situated one fourth the length of seta from margins of cephalothoracic shield at points one half the distance from anteromedial extremity to stigmatal openings; setae of second pair one and one-third times as long as setae of first pair, located one third length of seta behind and slightly medial to areoli of pseudostigmatic organs. Hysterosoma with first pair of setae as long as combined lengths of genu and tibia II, located on lateral margins of body the length of seta behind posterior margins of coxae II; second pair of setae with length subequal to length of first pair, located slightly more than the length of seta from lateral margins of body about in line with anterior extremities of coxae III; setae of third pair two thirds as long as setae of first pair, situated one half length of seta anterior to hysterosomal suture transecting body at basal fifth of opisthosoma, separated from each other by a distance equal to four times length of seta; fourth pair of setae subequal in length to third pair, one half as long as tibia III, located on lateral margins of body one half length of seta anterior to last opisthosomal suture; setae of fifth and sixth pairs as long as setae of fourth pair, located one half length of seta from last opisthosomal suture, separated from each other by a distance equal to one and one-half times length of seta. *Ventral chaetotaxy:* Propodosoma with first pair of setae as long as genu II, located one half length of seta from anterior margin of ventral plate, this distance from median apodeme; setae of second pair twice as long as setae of first pair, situated on apodemes II at about their mid-lengths. Hysterosoma with first pair of setae having length equal to width of genu II, located just anterior to anteromedial extremities of apodemes III; setae of second pair with length subequal to setae of first pair, located one half greatest width of coxa III mesad from inner margins of coxae III at their posterior two fifths; third pair of setae with length equal to length of terminal segment of leg IV, located near apex of body and separated from each other by a distance equal to one and one-half times length of seta. *Capitulum:* Subcordate with posterior margin rounded truncate; length including projecting palpi, 36μ; width at greatest dimension, 25μ. Dorsal setae as long as genu II, located in line with bases of palpi and separated from each other by a distance equal to length of seta. Ventral setae as long as dorsal setae, located in line with the latter and separated from each other by a distance equal to three fourths length of seta. Palpi short and stout, indistinctly segmented, their bases inserted on apical fifth of capitulum. Chelicerae short, needlelike, projecting forward between palpi to a point in line with apices of the latter; cheliceral sheaths prominent, without striae. *Legs:* Anterior pairs short and stout. Leg I with coxa subtriangular, one and one-half times as broad as long, without setae; femur with length equal to one half width of capitulum, inner margin one half as long as outer, segment with greatest width equal to length, tapering from base toward apex, with one stout, elongate seta and three normal setae; genu two thirds as long as femur, slightly longer than broad, with four normal setae; tibiotarsus stout, twice as long as genu, three times as long as broad at base, tapering slightly from base to broadly rounded apex, with one capitate, annulated seta with length equal to one half basal width of segment, located dorsally one half the length of seta from base on outer margin of segment, one rodlike seta slightly longer than capitate seta, located dorsally near outer margin at basal sixth, one seta nearly as long as segment located dorsally near outer margin at basal sixth, one seta one third as long as segment located middorsally at basal fifth, one clavate, annulated seta with length equal to two thirds basal width of segment located dorsally near outer margin at basal third, one seta one half as long as segment located near outer margin at apical third, one stout, curved seta one third as long as segment located middorsally at apex, one ventral seta one half as long as segment located near outer margin at basal fourth, one ventral seta one half as long as segment located near inner margin at basal third, one mid-ventral seta one third as long as segment located at about mid-segment, one ventral seta one third as long as segment located on inner margin at apical third, one ventral seta one third as long as segment located on outer margin at apical third, one stout, curved seta one fourth as long as segment located ventrally on inner margin at apex, one stout, curved, ventral seta one third as long as segment located near outer margin just before apex; tarsus surmounted by a short pretarsus bearing at its apex a small, curved claw and small empodium. Leg II with coxa subquadrangular, as broad as long, length equal to length of genu I, without vestiture; femur slightly longer than femur I, slightly longer than broad, tapering toward apex, with three normal setae; genu one half as long as femur, as long as broad at base, tapering slightly toward apex, with three setae; tibia one and one-fourth times as long as genu, one and one-fourth times as long as broad, lateral margins subparallel, with four setae; tarsus one and one-half times as long as tibia, two and one-half times as long as broad at base, tapering from base to narrowly rounded apex, with one dorsal, peglike seta with length equal to one half basal width of segment located near outer margin at base, one ovate, annulated seta as long as peglike seta, located on outer margin near base, five normal setae; tarsus terminated by a narrow pretarsus, its length equal to basal width of tarsus and bearing at its apex two stout, curved, spreading claws between and beyond which projects a broad empodium. Leg III with coxa elongate oval, length equal to combined lengths of genu and tibiotarsus I, one third as broad as long, lateral margins convex at anterior two thirds, constricted at posterior third, expanding caudad from this point, segment without vestiture; femur nearly one half as long as coxa, outer margin constricted at basal two fifths of segment expanding bulbous basad from this point, sides diverging distad from constriction, segment with two setae; tibia slightly longer than femur, lateral margins converging slightly from basal third toward apex, with three setae; tarsus narrow, elongate, length equal to length of femur, lateral margins subparallel, segment with three setae; tarsus exceeded by a narrow pretarsus one third as long as tarsus, bearing at its apex two curved, spreading claws between and beyond which extends a broad empodium. Leg IV with coxa small, subtriangular, broader than long, without vestiture; trochanter small, ringlike, one and one-half times as broad as long, without setae; third segment slender, elongate, as long as tibiotarsus I, outer margin straight, inner margin slightly concave, segment with one ventral seta one third as long as segment, located on outer margin at base, one seta two thirds as long as segment located ventrally near outer margin at apical third; fourth segment narrow, elongate, three times as long as broad at base, expanded slightly at apex, with one stout seta as long as combined lengths of third and fourth segments, located near outer margin at apical third, one terminal seta nearly twice as long as leg IV. *Measurements:* Apex of cephalothoracic shield to tip of opisthosoma, 148μ; tip of shield to main body suture, 61μ; width of body at main body suture, 74μ; width at anterior extremities of coxae III, 88μ; distance between anterior condyles of coxae III, 47μ.

Holotype: Male from Avancino-Mortensen nursery San Leandro, California, September 26, 1949, R. E. Beer, on dead flower of spathiphyllum.

Allotype: Female, same data as holotype.

Paratypes: Five males, ten females and one larva, same data as holotype.

Location of types: Holotype, allotype, three male and six female paratypes, with the same data as the holotype, in the Snow Entomological Museum, University of Kansas. Two male and four female paratypes, with the same data as the holotype, in the U. S. National Museum.

This species is distinguished from *T. confusus* and *T. waitei,* with which it seems to bear a close affinity, on characters of the male leg IV and the presence of an elongate extra seta on femur I of the female.

Living specimens of this species are opaque white in the immature and young adult stages, the older adults becoming a slight amber color. This species is definitely a fungus feeder. In biological investigations conducted by the present writer several generations were reared on agar slants containing cultures of fungus (unidentified) taken from dead flowers of *Spathiphyllum* sp. from the type locality.

During the course of biological studies "pupae" of this species were observed being carried by males of *Tarsonemus setifer* which were introduced into the culture.

This species was named after Dr. A. Earl Pritchard of the University of California, who was instrumental in arousing the interest of the present author in the family Tarsonemidae.

Tarsonemus unguis Ewing

(Plates 12 and 20)

Tarsonemus unguis Ewing, 1939, U. S. Dept. Agr. Tech. Bull., 653, p. 30.

Male: Body broadly oval, broadest near posterior extremities of coxae III; legs moderately long and robust, with legs I slightly longer than legs II; apodemes distinct and clearly defined; genital papilla smaller than capitulum; anal plate relatively small. Apodemes I as long as inner margin of femur I, extending in posteromedial directions from innermost angles of coxae I, converging medially to form a Y-shaped juncture with anterior extremity of median apodeme. Apodemes II about one and one-half times as long as apodemes I and subparallel to the latter for most of their lengths, extending from innermost angles of coxae I and curving rather abruptly in a posterior direction just before mid-body, terminating a short distance beyond the curve, the rather indistinct mesal terminations of these apodemes separated from each other by a distance equal to the basal width of tarsus II and the length of tibia II anterior to main body suture. Transverse apodeme apparently absent or very obscure. Anterior median apodeme extending from point of juncture with apodemes I to a point in transverse alignment with the curves just before the mesal extremities of apodemes II. Apodemes III strong and distinct, extending in smooth, anteromesally directed arcs from anterior condyles of coxae III to juncture with apodemes IV at points the length of tibia II laterad from median apodeme. Apodemes IV extending in anteromedial directions from outer basal angles of coxae IV, converging gently with apodemes III and extending in a short transverse arc after juncture with apodemes III to point of contact with median apodeme, this point being one and one-half times the length of tibia II behind main body suture. Posterior median apodeme extending from point slightly anterior to juncture of apodemes IV to point slightly anterior to inner basal angles of coxae IV, bifurcating here with each short arm of the apodeme continuing to inner basal angles of coxae IV, this apodeme discontinuous for a short distance in two places, one immediately behind juncture of apodemes IV, the other slightly anterior to bifurcation. A hysterosomal suture transects body dorsally near anterior extremity of genital papilla. Dorsum of propodosoma with anterior margin broadly and angularly truncated, its transverse dimension slightly exceeding the width of capitulum and equal to the combined lengths of femur, genu and tibia I. *Dorsal chaetotaxy:* First pair of dorsal propodosomal setae with length equal to twice length of tarsus I, situated one third length of seta behind anterior margin of propodosoma and separated from each other by a distance equal to one half length of seta; second pair of setae with length equal to four fifths the length of first setae, situated behind and slightly laterad from setae of first pair a distance about equal to one half length of first seta; third setae more than twice as long as setae of first pair, situated behind and slightly laterad from second setae a distance equal to that separating first and second setae; fourth pair of dorsal propodosomals about as long as first setae, situated laterad from third setae a distance equal to slightly less than one half the distance separating second and third setae. First pair of dorsal hysterosomal setae as long as first propodosomals, located near lateral margins of body four fifths length of seta behind main body suture; second and third pairs of setae subequal in size, four fifths as long as setae of first pair; fourth dorsal hysterosomal setae one-half as long as third setae, situated at lateral margins of genital papilla at about mid-length of papilla. *Ventral chaetotaxy:* First pair of ventral propodosomal setae as long as genu II, situated two thirds length of seta laterad from juncture of apodemes I; second pair of setae as long as first pair, located near centers of areas delimited by apodemes II, main body suture and basal margins of coxae II. First pair of ventral hysterosomal setae nearly twice as long as first ventral propodosomals, located immediately behind apodemes III at mesal thirds of these apodemes; second pair of setae three fourths as long as first ventral hysterosomals, situated on apodemes IV midway between posterior extremities of apodemes and points of juncture with apodemes III. *Capitulum:* Subcordate with anterior margin rounded and having a slight mesal emargination; length including projecting appendages, 30μ; greatest width, measured at about mid-length, 30μ. Dorsal setae short, length equal to one fourth width of capitulum and situated near anterolateral angles of capsule, separated from each other by a distance equal to their combined lengths. Ventral setae slightly shorter than dorsal setae, situated near palpal bases and separated from each other by a distance equal to one and one-half times length of seta. Palpi short and stout, projecting a short distance beyond apex of capsule, indistinctly segmented and ornamented. Styliform chelicerae short, projecting between but not beyond palpi; cheliceral sheaths without transverse striae. *Legs:* Leg I with coxa subquadrangular, about one and one-third times as broad as long, without vestiture; femur robust, length equal to width of coxa, with four setae; genu slightly broader than long, with four setae; tibia slightly longer than broad, with one small, clavate, annulated seta with length equal to two fifths basal width of segment, located mid-dorsally the length of seta before base of segment, one rodlike seta about one and one-half times as long as segment, located dorsally near outer margin one half length of segment from base, one capitate seta as long as rodlike seta, situated between the clavate and the rodlike setae, four normal setae; tarsus one and one-half times as long as tibia, twice as long as broad at base, tapering from base to narrowly rounded apex, with one stout, lanceolate, annulated seta with length equal to three fourths basal width of segment, situated dorsally near outer margin the length of seta from base of segment, six normal setae; tarsus surmounted by a short, slender pretarsus which subtends a small, curved claw and a small empodium. Leg II with coxa subquadrangular, one and one-third times as broad as long, without vestiture; femur robust, as broad as long, with two small setae; genu one and one-half times as broad as long, tapering slightly from base to apex, with three setae; tibia one and one-half times as long as genu, tapering from base toward apex, with four normal setae; tarsus slightly longer than tibia, more than twice as long as broad at base, tapering from base to narrowly rounded apex, with one large, clavate, annulated seta with length equal to basal width of segment, situated dorsally near inner margin at base of segment, four normal setae; tarsus surmounted by a short, slender pretarsus which subtends two large, curved, spreading claws between which projects a broad empodium. Leg III with coxa about twice as long as broad, without vestiture; femur two thirds as long as coxa and one half as broad as long, basal third of segment bulbous and separated from remainder of segment by a slight constriction and an incomplete suture, the telofemur with one ventral seta; genu about two fifths as long as femur, as broad as long, with three setae; tibia slightly longer than genu, with four setae; tarsus slightly longer than tibia, about twice as long as broad at base, tapering from base to narrowly rounded apex, with three setae; tarsus subtends a short, slender pretarsus which bears at its apex two large, curved, spreading claws between and beyond which projects a broad, bilobed empodium. Leg IV with coxa large and subquadrangular, about three fourths as long as broad, with one ventral seta; femur robust, length equal to one and one-half times width of coxa, about twice as long as broad at base and one half as broad at apex as at base, with one long, dorsal seta as long as segment, situated near apical third on outer margin, one ventral seta as long as basal width of segment, located near apex of inner margin, one small, ventral seta having length equal to one half apical width of segment, located on inner margin at basal two fifths; tibia short and stout, about as broad as long, with one stout, tactile seta nearly as long as femur, located mid-ventrally at apex of segment, one slender, rodlike seta with length equal to three fourths width of segment, situated near outer margin at about mid-segment; tarsus collarlike, about twice as broad as long, with two short dorsal setae and one short ventral seta; tarsus subtends a large, curved claw with length equal to length of tibia. *Genital papilla:* Large and subcircular in general outline with a slight mesal emargination on its anterior margin; length, including projecting appendages, 26µ; greatest width, measured at mid-length, 26µ. *Anal plate:* Relatively small but conspicuous, its triradiate apodemes projected to an expanse equal to one half width of capitulum. *Measurements:* Total length, from tips of palpi to apex of genital papilla, 174µ; anterior margin of propodosomal hood to apex of genital papilla, 150µ; anterior margin of hood to main body suture, 78µ; width of body near mid-lengths of coxae III, 97µ.

Type: Belle, Maryland, Oct. 16, 1933, F. F. Smith, strawberry (single male).

Location of type: U. S. National Museum, slide number 1126.

The above description was made from the holotype specimen and the species remains known from this single specimen.

Tarsonemus scaurus Ewing

(Plates 14, 20 and 24)

Tarsonemus scaurus Ewing, 1939, U. S. Dept. Agr. Tech. Bull., 653, p. 28.

Male: Body broadly oval, broadest immediately behind main body suture; legs moderately long and of medium robustness, with legs I slightly longer than but not as stout as legs II, legs IV relatively small; genital papilla large and conspicuous, much broader than capitulum; anal plate large and well defined. Apodemes strong and distinct, those of legs I, as long as genu I, extending in posteromedial directions from innermost angles of coxae I, converging medially to form a Y-shaped juncture with anterior extremity of median apodeme. Apodemes II two and one-half times as long as apodemes I and subparallel to the latter, extending from innermost angles of coxae II almost to juncture with median apodeme, the mesal extremities of apodemes II curved toward posterior just before juncture with median apodeme. Transverse apodeme strong and conspicuous, transecting body just anterior to main body suture, the lateral extremities located the length of genu II behind the outer basal angles of coxae II, the apodeme curved slightly forward just before juncture with median apodeme. Anterior median apodeme strong and distinct for most of its length, extending from juncture of apodemes I to intersection with transverse apodeme. Apodemes III clear and distinct for their entire lengths, extending in anteromedial directions from anterior condyles of coxae III for a distance equal to combined lengths of genu and tibia II, here starting a smooth, ninety degree curve to join apodemes IV. Apodemes IV nearly parallel to apodemes III for most of their lengths, extending from outer, basal angles of coxae IV to point of juncture with apodemes III, here being separated from each other by a distance equal to length of tibia II, smoothly curving mesially from points of juncture with apodemes III to converge at anterior extremity of median apodeme, these short, anteromesal portions of apodemes IV being much weaker than remainder of their lengths. Posterior median apodeme with anterior extremity behind main body suture a distance equal to combined lengths of tibia and tarsus II, extending caudad to point between inner apical angles of coxae IV, the apodeme strong and distinct for its entire length. A distinct hysterosomal suture transects body dorsally in region of posterior extremities of coxae III. Dorsum of propodosoma with anterior margin angularly and broadly truncate, this margin being as broad as capitulum and forming a hood over extreme posterior portion of capitulum. *Dorsal chaetotaxy:* First pair of dorsal propodosomal setae as long as capitulum, situated one half length of seta behind anterior margin of hood, nearly this distance from lateral margins of propodosomal plate, the setae separated from each other by a distance about equal to one half width of anterior margin of cephalothoracic hood; second pair of setae two thirds as long as setae of first pair, situated behind and slightly laterad from the latter a distance equal to length of second setae; third pair of dorsal propodosomal setae nearly twice as long as setae of first pair, located behind and slightly laterad from second setae a distance slightly less than that separating first and second setae; fourth pair of setae as long but not as stout as first setae, located laterad from and slightly posterior to third setae, separated from the latter by a distance equal to one half the distance between first and second setae. First pair of dorsal hysterosomal setae with size subequal to fourth propodosomals, situated near lateral margins of body the length of seta behind main body suture; second setae stouter and slightly shorter than setae of first pair; third dorsal hysterosomals stout, nearly as long as setae of second pair; fourth pair of setae also stout, about two thirds as long as setae of second pair, located at lateral margins of genital papilla near mid-length of papilla. *Ventral chaetotaxy:* First pair of ventral propodosomal setae with length equal to basal width of tarsus I, located the length of seta laterad from point of juncture of apodemes I; second ventral propodosomals slightly longer than setae of first pair, situated the length of seta behind apodemes II at about mid-lengths of apodemes. First pair of ventral hysterosomal setae one and one-half times as long as second ventral propodosomals, located immediately behind the most anterior points of the arcs formed by apodemes III at the anteromesal extremities of these apodemes; second pair of setae slightly shorter than setae of first pair, situated on apodemes IV at about the posterior two fifths of the lengths of apodemes. *Capitulum:* Small and subcordate, with posterior margin rounded, truncate and having a slight, mesal invagination. Length, including projecting palpi, 22μ; greatest width, measured at posterior fourth, 18μ. Dorsal setae with length equal to one half width of capitulum, situated near anterolateral extremities of capsule. Ventral setae slightly shorter than dorsal setae, located near bases of palpi and separated from each other by a distance equal to length of seta. Palpi moderately short and stout, projecting a short distance beyond apex of capitulum, indistinctly segmented and ornamented. Styliform chelicerae short, projecting between but not beyond palpi; cheliceral sheaths without striae. *Legs:* Leg I with coxa subquadrangular, slightly broader than long, without vestiture; femur of moderate size, one and one-third times as long as broad, with three setae; genu slightly longer than broad, with four setae; tibia slightly longer than genu, with one small, clavate, annulated seta having length equal to one third basal width of segment located dorsally near outer margin the length of seta from base of segment, one capitate seta slightly longer than clavate seta, situated beside the latter, five normal setae; tarsus moderately slender and elongate, about four times as long as broad at base, tapering slightly toward broadly rounded apex, with one large, lanceolate, annulated seta having length slightly greater than basal width of segment, located dorsally, near outer margin one third length of seta from base of segment, five normal setae; tarsus surmounted by a short, slender pretarsus bearing at its apex a long, curved claw and a large empodium. Leg II with coxa subquadrangular, as broad as long, without vestiture; femur nearly as broad as long, outer margin twice as long as inner margin, with two setae; genu as broad as long, with three setae; tibia one and one-half times as long as broad, with four setae; tarsus one and one-half times as long as tibia, about three times as long as broad at base, tapering from base to narrowly rounded apex, with one large, broad, lanceolate, annulated seta two fifths as long as segment, located dorsally near inner margin one half greatest width of segment from its base, four normal setae; tarsus surmounted by a short, broad pretarsus which subtends two large, curved, spreading claws between which projects a broad empodium. Leg III with coxa moderately long, length equal to one and one-half times its greatest breadth, without vestiture; femur slightly more than one half as long as coxa, segment divided into a bulbous basifemur and a broad telofemur by an incomplete suture and a conspicuous constriction, telofemur expanding toward apex and bearing one small, ventral seta; genu one half as long as femur, about as broad as long, with three setae; tibia slightly longer than genu, one and one-third times as long as broad, with four setae; tarsus slightly longer than tibia and with a slight taper from base to broadly rounded apex, with three setae; tarsus surmounted by a short, broad pretarsus with imbricated margins which subtends two large, curved, spreading claws between which projects a broad empodium. Leg IV with entire length, excluding claw, equal to combined lengths of femur, genu, tibia and tarsus III; coxa subtriangular, slightly broader than long, with one ventral seta; femur with outer margin nearly straight, as long as combined lengths of femur and genu III, inner margin slightly longer than outer margin and sharply angulate at basal sixth, converging with outer margin uniformly distad from this angle, width of segment at base equal to one half length of outer margin and twice width of segment at apex, with one dorsal seta two thirds as long as segment, situated near outer margin the apical width of segment before apex, one stout ventral seta four fifths as long as segment, located near inner apical margin of segment, one small ventral seta having length equal to apical width of segment, situated on inner margin at basal two fifths; tibia short, slightly longer than broad, with one rodlike seta having length equal to width of segment, situated dorsally near outer margin at mid-segment, one stout ventral seta with length equal to combined lengths of femur and tibia, situated at apex of segment, its areolus with diameter almost equal to width of segment; tarsus small and inconspicuous, one half as long as broad, with two small dorsal setae and one small ventral seta; tarsus subtends a strong, sharp, slightly curved claw with length equal to length of tibia. *Genital papilla:* Large and broadly subcordate, with anterior margin deeply emarginate; length, 23μ; greatest width, measured near anterior extremity, 33μ. *Anal plate:* Large and conspicuous, the central disc with diameter equal to apical width of femur IV, triradiate apodemes each as long as genu III. *Measurements:* Length of body from tips of palpi to apex of genital papilla, 150μ; anterior margin of cephalothoracic hood to apex of genital papilla, 130μ; anterior margin of hood to main body suture, 45μ; width of body immediately behind main body suture, 75μ; width at anterior condyles of coxae III, 67μ.

Female: Body broad, oval, broadest slightly behind main body suture. Legs moderately short and stout, legs I longer than but not as stout as legs II; innermost angles of coxae IV separated by a distance slightly greater than length of coxa IV. Apodemes moderately well-defined, those of legs I as long as basal width of tibiotarsus I, extending in posteromedial directions from innermost angles of coxae I, converging to form a Y-shaped juncture with anterior extremity of median apodeme. Apodemes II twice as long as and subparallel to apodemes I, extending from innermost angles of coxae II to points the length of apodeme I laterad from median apodeme. Transverse apodeme moderately strong and distinct, transecting body immediately anterior to main body suture, less distinct mesially than at its lateral extremities. Anterior median apodeme distinct only from point of convergence of apodemes I to point in line with mesal extremities of apodemes II. Apodemes III distinct only for a short distance extending anteromedially from anterior condyles of coxae III. Apodemes IV distinct only for a short distance in the region of posterior fifths of coxae III. Posterior median apodeme relatively inconspicuous. Transverse body sutures, except for main body suture, indistinct due to poor condition of specimen. Dorsum of propodosoma with anterior margin broadly rounded, projecting over basal half of capitulum. Pseudostigmatic organs with expanded apices broadly oval, the diameter of expansion subequal to length of slender pedicel. Stigmatal openings clear and distinct, situated near lateral margins of propodosoma immediately posterior to the lateral indentations which separate the main dorsal plate of the propodosoma from the hoodlike anterior extension. *Dorsal chaetotaxy:* First pair of dorsal propodosomal setae with length about equal to two thirds width of capitulum, situated near lateral margins of hood at about mid-length of hood; second dorsal propodosomals longer than leg I, situated midway between stigmatal openings and main body suture. First pair of dorsal hysterosomal setae slightly shorter than first propodosomals, located near lateral margins of body one half length of seta from main body suture; remaining dorsal hysterosomal setae not clearly identifiable in the specimen studied. *Ventral chaetotaxy:* First pair of ventral propodosomal setae with length equal to two thirds basal width of tibiotarsus I, situated slightly behind apodemes I at their mid-lengths; second pair of setae one and one-half times as long as setae of first pair, situated on apodemes II at mid-lengths of apodemes. First and second pairs of ventral hysterosomal setae not identifiable due to poor condition of specimen. *Capitulum:* Large and broadly subcordate, with posterior margin rounded truncate; length, including projecting palpi, 32μ; greatest width, measured at posterior sixth, 28μ. Dorsal setae with length equal to one fourth width of capitulum, situated near anterolateral extremities of capsule. Ventral setae with length subequal to dorsal setae, situated near bases of palpi and slightly more approximate to each other than are the dorsal setae. Palpi short and stout, projecting a short distance beyond apex of capitulum, indistinctly segmented and ornamented. Chelicerae short and styliform, projecting between but not beyond palpi; cheliceral sheaths without striae. *Legs:* Leg I with coxa subquadrangular, as broad as long, without vestiture; femur slightly longer than broad, with four setae; genu as broad as long, with four setae; tibiotarsus about three times as long as broad at base, tapering from base to broadly rounded apex, with one small, clavate, annulated seta having length equal to one third basal width of segment, situated dorsally near outer margin one half length of seta from base of segment, one capitate seta as long as clavate seta, situated beside the latter, one rodlike seta about twice as long as clavate seta, situated ventrally immediately beside capitate seta, one large, broad, lanceolate, annulated seta with length equal to three fourths basal width of segment, situated dorsally near outer margin just proximad from mid-segment, one extremely long tactile seta as long as combined lengths of tibiotarsus and pretarsal elements, eight normal setae; tibiotarsus surmounted by a short, broad pretarsus bearing at its apex a strong, curved claw and a small empodium. Leg II with coxa subquadrangular, as broad as long, without vestiture; femur robust, as broad as long, with three setae; genu as broad as long, with one stout, spinelike seta as long as segment, situated dorsally near outer margin at base, two normal setae; tibia as long as genu, as broad as long, with four normal setae; tarsus one and one-half times as long as tibia, tapering from broad base to narrowly rounded apex, with one clavate, annulated seta having length equal to one half basal width of segment, situated dorsally near outer basal margin, one spinelike seta slightly shorter than clavate seta situated dorsally between clavate seta and base of segment, one short, spurlike process projecting ventrally from inner apical margin of segment, three normal setae; pretarsal elements missing on specimen being described here. Leg III with coxa broad and elongate, without vestiture; femur as long as tibiotarsus I, basal two fifths of segment expanded, bulbous and separated from telofemur by a distinct constriction and an incomplete suture, telofemur expanding slightly from constriction toward its apex and bearing two setae; tibia as long as femur, sides slightly convex, with four normal setae; tarsus slender, elongate, about five times as long as broad, three fourths as long as tibia, with three long and one very short setae; pretarsal elements missing on specimen being described. Leg IV with coxa subtriangular, slightly longer than broad, without vestiture; trochanter small, collarlike, without a setae; third segment slightly longer than tibiotarsus I, about six times as long as broad at base, sides subparallel for most of their lengths, with one ventral seta two fifths as long as segment, situated near outer margin just before base, one seta one third as long as segment, located ventrally near outer margin one half length of seta before apex; fourth segment relatively short, less than one fourth as long as third segment, with one stout ventral seta as long as third segment, situated near outer margin at mid-segment, one teminal seta one and one-half times as long as the subterminal seta. *Measurements:* Length of body from tips of palpi to apex of hysterosoma, 138μ; anterior margin of cephalothoracic hood to tip of hysterosoma, 165μ; anterior margin of hood to main body suture, 71μ; width of body just posterior to main body suture, 122μ; distance between innermost margins of coxae IV, 21μ.

Types: Belle, Maryland, June 15, 1933, F. F. Smith, on strawberry (one male, two females, one larva).

Location of types: U. S. National Museum, number 1125.

The type specimens mounted on a single slide were remounted with one specimen on each of four slides. All specimens were poorly oriented on the original slide and the females were badly damaged in remounting, the male remaining in good condition. The redescription of the female given above was made from one of the cotype series, which, though damaged extensively presented the best material from which to draw a description. The male description given above was made from a specimen collected at Salem, N. J. as noted below. The male specimen in the series of four mites mounted on the "type" slide is hereby designated lectotype.

Material studied by the present writer, in addition to the cotype series, is identified with the following data: Salem, N. J., Sept. 21, 1949, John P. Reed, on tomato (several males); Univ. of Kansas campus, Lawrence, Kans., Mar. 22, 1951, R. E. Beer, leaf mold litter (three males).

This species is most easily confused with *T. confusus,* principally due to the fact that in the males of both species the femora IV are bent at a sharp angle just before the base of the segment. However, in specimens well oriented on the slide, the large acuminate claw of *T. scaurus* readily distinguishes the two, for males of *T. confusus* have very short claws. Also, the apodemes IV of *T. scaurus* are much more approximate to the median apodeme near their anterior extremities than are these apodemes in *T. confusus.* Females must be separated by more detailed characteristics, but in this sex the two mesal notches in the transverse apodeme of *T. confusus* ordinarily presents a good character for differentiation.

Tarsonemus truncatus Ewing

Tarsonemus truncatus Ewing, 1939, U. S. Dept. Agr. Tech. Bull., 653, p. 49.

This species is known from females only, three specimens mounted on a single slide representing the type series. The type slide is identified with the following data: Coeur d'Alene, Idaho, Aug. 15, 1931, H. J. Rust, on *Ips oregoni.* All specimens, although apparently in good condition, are oriented poorly on the slide and hence defied critical examination and attempts at formulating an adequate redescription by the present author.

One distinctive character readily separates this species from other known members of the family. This character is the reticulated integument, which has the undulating longitudinal striations slightly more pronounced than the wavy transverse striations. The eight pairs of dorsal body setae are stout, with the second dorsal propodosomals about twice as long as members of the other pairs. The stigmatal openings are prominent and are situated at indentations of the margins of the propodosomal shield which occur at the posterolateral extremities of the cephalothoracic hood, the latter having the width of its broadly rounded anterior margin slightly greater than width of capitulum and projecting to overhang basal half of capitulum. Dimensions of one of the cotype specimens are as follows: Length from tips of palpi to apex of opisthosoma, 140µ; greatest width of body, 84µ; tips of palpi to main body suture, 90µ; length of capitulum, including slightly projecting palpi, 30µ; greatest width of capitulum, 21µ.

Types: Three females, Coeur d'Alene, Idaho, Aug. 15, 1931, H. J. Rust, on *Ips oregoni*. One of the specimens has been encircled by the present writer and this specimen is hereby designated lectotype.

Location of types: U. S. National Museum, slide number 1135, further identified with the following: Hopk. U. S. 20258.

In general appearance this species seems to bear the nearest resemblance to *T. randsi* but may readily be distinguished on the basis of its integumental reticulations.

Genus *Rhynchotarsonemus,* new genus

This genus may be distinguished from all other tarsonemids by the pronounced prolongation of the palpi, in both sexes, which extend anteriorly to form a snoutlike extention of the capitulum. The genus is erected to include a single hitherto undescribed species.

Type of genus: *Rhynchotarsonemus niger,* new species.

In general characters this genus appears to bear a rather close resemblance to *Tarsonemus.* The conservative development of the male hind legs, general body structure and the indications of its fungivorous feeding habits have led this writer to place it as one of the unspecialized groups.

Rhynchotarsonemus niger, new species

(Plates 16, 21 and 25)

Male: Body broadly oval, broadest at middles of coxae III, tapering abruptly caudad from this point. Dorsum of propodosoma projected anteriorly forming a broad cephalothoracic shield with a truncate anterior margin as broad as capitulum. Legs narrow, elongate. Apodemes conspicuous and well defined, those of legs I extending from inner angles of coxae I at nearly right angles to median apodeme, curving abruptly caudad just before intersecting the latter; apodemes II extending from inner anterior margins of coxae II in a posteromedial directions terminating just before juncture with anterior median apodeme. Anterior median apodeme extending with interruptions from juncture of apodemes I to main body suture. Apodemes III extending in anteromedial directions from anterior extremities of coxae III, curving abruptly in transverse directions at points the length of tibia I behind main body suture, intersecting apodemes IV nearly midway between incurved angles and median apodeme. Apodemes IV subparallel to apodemes III for most of their lengths, extending from anterolateral angles of coxae IV, curving inward abruptly at anterior extremities of apodemes III, intersecting median apodeme at right angles. Posterior median apodeme extending from point the length of tibia I behind main body suture to inner basal angles of coxae IV, apodeme bifurcate at posterior third. *Dorsal chaetotaxy:* Propodosoma with four pairs of dorsal setae; first pair as long as capitulum, situated near anterolateral angles of cephalothoracic shield; setae of second pair about one half as long as first pair, located one half length of seta behind setae of first pair and equidistant from lateral margins of body; fourth pair of setae subequal in length to setae of second pair, located between setae of third pair and lateral margins of body, sligtly behind the former. Hysterosoma with four pairs of dorsal setae; first pair slightly longer than fourth pair of propodosomal setae, located near lateral margins of body opposite transverse line formed by anterior extremities of apodemes III and IV; second pair of setae stouter and slightly shorter than first pair, located near lateral margins of body opposite middles of coxae III; setae of third pair similar to setae of second pair, situated near caudolateral margins of hysterosoma; setae of fourth pair equal in length to setae of third pair but not as stout, situated near midlengths of lateral margins of genital papilla. *Ventral chaetotoxy:* Propodosoma with two pairs of ventral setae; first pair with length equal to length of genu I, located three fourths length of seta from median apodeme, one third length of seta behind apodemes I; second pair of ventral propodosomal setae as long as first pair, located one half length of seta directly behind apodemes II at their mid-lengths. Hysterosoma with two pairs of ventral setae, both pairs situated in interapodemal areas delimited by apodemes III and IV; setae of first pair slightly longer than tarsus III, located near apodemes III half length of seta behind anterolateral extremities of interapodemal areas; second pair of setae one and one-fourth times as long as first pair, located on apodemes IV the length of seta from posterior extremities of apodemes. *Capitulum:* Subcordate, with posterior margin emarginate, palpi and chelicerae extending beyond apex of capitulum a distance equal to one half greatest width of capitulum; length including projecting appendages, 40μ; greatest width, 22μ. Dorsal setae with length equal to one half greatest width of capitulum, situated near apex of capitulum, separated from each other by a distance equal to two thirds length of seta. Ventral setae nearly as long as dorsal setae, located opposite the latter. Palpi narrow, elongate, indistinctly segmented, length equal to combined lengths of tibia and tarsus I. Chelicerae needlelike, projecting forward between palpi, their apices nearly in line with apices of palpi; cheliceral sheaths prominent, without striae. *Legs:* Narrow, elongate, anterior pairs subequal in size. Leg I with coxa subquadrangular, broader than long, without vestiture; femur with length slightly less than one half greatest width of capitulum, two thirds as broad as long, with four setae; genu two thirds as long as femur, one and one-half times as long as broad, sides subparallel, with four setae; tibia as long as genu, twice as long as broad, lateral margins subparallel, with one lanceolate, sensory seta one-half as long as width of segment, situated dorsally at about mid-segment, two normal and two long tactile setae; tarsus as long as tibia, two and one-half times as long as broad at base, tapering to narrow apex, with one lanceolate, annulated, sensory seta having length nearly equal to basal width of segment, located near inner margin at about apical third, three normal and four long, tactile setae; tarsus surmounted by short, narrow pretarsus with length about equal to basal width of tarsus, bearing at its apex a small empodium beyond which projects a stout, curved claw. Leg II with coxa robust, subquadrangular, one and one-fourth times as broad at base as long, lateral margins convex, segment without setae; femur one and one-third times as long as genu I, one and one-fourth times as long as greatest breadth, with three setae; genu subquadrate, two thirds as long as femur, with three setae; tibia as long as genu, one and one-third times as long as broad, sides subparallel, with four setae; tarsus as long as tibia, twice as long as broad at base, tapering to broadly rounded apex, with one ovate, annulated seta having length slightly less than basal width of segment, located dorsally near outer margin at base, one short, peglike seta as long as apical width of segment, located near inner margin at apex, two normal and one long, tactile setae; tarsus surmounted by a short pretarsus with length equal to two thirds basal width of tarsus, bearing at its apex two strong, curved, spreading claws between which projects a broad empodium. Leg III with coxa subtriangular, slightly longer than femur II, without vestiture; femur as long as tibia I, inner margin nearly twice as long as outer margin, width at apex about one half length of segment, with one ventral seta; genu two thirds as long as femur, one and one-fourth times as long as broad, sides subparallel, three setae present on segment; tibia one and one-fifth times as long as genu, one and one-half times as long as broad, lateral margins subparallel, with four setae; tarsus nearly as long as tibia, twice as long as broad at base, tapering from base to narrowly rounded apex, with one tactile seta and four normal setae; tarsus surmounted by a short, narrow pretarsus with length equal to two thirds basal width of tarsus, bearing at its apex two large, curved, spreading claws between and beyond which extends a broad, bilobed empodium. Leg IV with coxa subtriangular, one and one-third times as broad as long, with one seta; femur nearly as long as leg I, one third as broad at base as long, tapering from base to apical third, of uniform width distad from this point, outer margin slightly convex, inner margin convex at basal fifth remainder concave, with one dorsal seta two thirds as long as segment located near outer margin at apical third, one ventral seta with length equal to two thirds basal width of segment situated at mid-point on inner margin, one ventral seta slightly less than one half as long as segment located near inner margin one fourth length of seta from apex; tibia with length equal to three fourths width of femur at apex, inner margin slightly concave, two thirds as long as convex outer margin, with one lanceolate, annulated seta situated dorsally near outer margin at apical fourth, one stout, tactile seta nearly three times as long as segment located ventrally near mid-segment at apical third; tarsus small, slightly less than one half as long as tibia, about twice as broad as long, with one dorsal seta three times as long as segment located near inner margin at apex, one dorsal seta slightly longer than segment located near outer margin at apex, one ventral seta with length equal to two thirds width of segment situated near inner margin at mid-segment; tarsus surmounted by a short, broad, curved claw with length equal to width of tarsus, width at base about one half its length. *Genital papilla:* Length, 26µ; width, 29µ; subcordate with anterior margin emarginate, posterior margin broadly truncate. *Measurements:* Overall length from tips of projecting palpi to apex of genital papilla, 184µ; anterior margin of cephalothoracic shield to main body suture, 47µ; main body suture to apex of genital papilla, 100µ; width of body at main body suture, 78µ; width of body at coxae III, 113µ.

Female: Body short, oval, broadest at mid-length. Anterior apodemes well defined, those of legs I with length equal to width of tibia II, extending from innermost angles of coxae II to median apodeme, converging medially at nearly a right angle to the latter. Apodemes II subparallel to apodemes I, two and one-half times as long as the latter, their posterior extremities slightly incurved and separated from median apodeme by a distance equal to half their lengths. Anterior median apodeme extending conspicuously from Y-shaped juncture of apodemes I to a point in line with medial extremities of apodemes II, continuing obscurely to main body suture. Apodemes III as long as genu I, extending in nearly transverse directions from anterior condyles of coxae III, apodemes terminating medially at points on first hysterosomal suture slightly less than half the distance from anterior condyles of coxae III to median apodeme. Apodemes IV two thirds as long as coxae III, extending in anteromedial directions from points the width of coxa III mesad from inner margins of coxae III at their posterior thirds to point of convergence on median apodeme slightly behind first hysterosomal suture, apodemes with a small, knoblike thickening at their mid-lengths. Posterior median apodeme extending from point in line with posterior extremities of apodemes IV to a point just anterior to first hysterosomal suture, dividing at this point, each arm of the Y-shaped anterior extremity of apodeme as long as basal width of tibiotarsus I and forming nearly a right angle with one another. Four distinct hysterosomal sutures transecting body, one near anterior extremities of coxae III, one at anterior extremities of coxae IV, one midway between second suture and apex of body and one three fourths the distance from third suture to apex. Pseudostigmatic organs one and one-third times as long as tibia II, broadly oval, expanded apex slightly longer than narrow pedicel, diameter of basal ring slightly less than greatest breadth of expanded apex. Stigmatal openings situated slightly behind and laterad from first pair of dorsal propodosomal setae; tracheae clearly visible, extending posteromedially from stigmatal openings and intersecting medially at a point the length of apodemes I behind anterior extremity of anterior median apodeme, continuing less distinctly caudad from this point, tracheal pouches absent. Propodosoma projected dorsally beyond stigmatal openings to form a broadly rounded cephalothoracic shield which overlays basal portion of capitulum, apex of shield extending almost to bases of palpi. *Dorsal chaetotaxy:* Propodosoma with two pairs of dorsal setae; first pair as long as combined lengths of tibia and tarsus II, situated near lateral margins of cephalothoracic shield, four fifths length of seta from apex of shield; setae of second pair as long as combined lengths of genu and tibiotarsus I, located one fourth length of seta behind and slightly laterad from basal rings of pseudostigmatic organs. Hysterosoma with six pairs of dorsal setae; first pair as long as combined lengths of genu and tibia II, situated on lateral margins of body just behind main body suture; second pair of setae slightly shorter than first pair, located the length of seta from lateral margins of body in line with point slightly anterior to mid-lengths of coxae III; third pair of dorsal hysterosomal setae as long as tibia II, situated the length of seta laterad from postero-lateral angles of coxae IV; fourth pair of setae with length subequal to third pair, situated on lateral margins of body half length of seta anterior to penultimate hysterosomal suture; fifth pair of setae slightly longer than setae of fourth pair, located in line with the latter and separated from each other by a distance equal to one and one-third times length of seta; sixth pair of setae as long as fifth pair, located on penultimate segment half length of seta from lateral margins of body, four fifths length of seta from caudal margin of segment. *Ventral chaetotaxy:* Propodosoma with two pairs of ventral setae; first pair as long as genu II, located one half length of seta laterad from anterior extremity of median apodeme; second pair of setae as long as tibia II, situated on apodemes II at their anterior thirds. Hysterosoma with two pairs of ventral setae; first pair as long as genu II, located two thirds length of seta anteromedial from mesal extremities of apodemes III; setae of second pair subèqual in length to setae of first pair, situated at caudal extremities of apodemes IV. *Capitulum:* Subcordate, with posterior margin broad, truncate; length not including palpi, 32µ; length including extended palpi, 50µ; greatest width, 32µ. Dorsal setae two thirds as long as tibiotarsus I, situated in line with bases of palpi, separated from each other by a distance equal to one half length of seta. Ventral setae slightly longer than dorsal setae, projecting forward nearly as far as palpi, located nearly opposite dorsal setae but slightly more approximate. Palpi three-segmented, basal segment short, its length equal to basal width of tarsus II, about one and one-half times as long as broad; second segment one and one-half times as long as first segment, about twice as long as broad; third segment slightly longer than second, slightly tapering to broadly rounded apex, the apex adorned with numerous tubercles and two short setae. Chelicerae elongate, styliform, projecting forward as far as palpi; cheliceral sheaths prominent, with numerous, minute, transverse striae. *Legs:* Anterior pairs short and stout. Leg I with coxa subtriangular, as broad at base as long, without setae; femur with length about two thirds greatest width of capitulum, one and one-half times as long as broad at base, tapering slightly to apex, with three setae; genu about two thirds as long as femur, one and one-fourth times as long as broad at base, tapering slightly toward apex, with four setae; tibiotarsus about one and one-third times as long as femur, nearly four times as long as broad at base, lateral margins converging beyond distal third of segment to broadly rounded apex, with one long, tactile seta slightly longer than segment located middorsally at base, one minute, clavate, annulated seta with length equal to one fourth basal width of segment situated dorsally on outer margin twice length of seta from base, one seta two fifths as long as segment located dorsally near inner margin at basal third, one stout seta two fifths as long as segment located dorsally near inner margin at apical fourth, one dorsal seta with length slightly more than one third length of segment located near outer margin at apex, one ventral seta one fourth as long as segment located near outer margin at basal third, one ventral seta two thirds as long as segment located near inner margin at basal third, one ventral seta one half as long as segment situated on inner margin at basal third, one ventral seta one third as long as segment located on inner margin at apical third, one lanceolate, annulated seta having length equal to two thirds basal width of segment situated ventrally on outer margin at apical third, one stout, curved seta one third as long as segment located on outer margin at apex, one stout, curved seta one third as long as segment located on inner margin at apex; tibiotarsus surmounted by a short pretarsus, length equal to one half basal width of tibiotarsus, bearing at its apex a broad empodium beyond which extends a stout, curved claw. Leg II with coxa subquadrangular, slightly broader than long, without vestiture; femur three fourths as long as femur I, as broad as long, with three setae; genu one half as long as femur, one and one-third times as broad at base as long, tapering slightly toward apex, with two setae; tibia as long as basal width of genu, sides subparallel, with three setae; tarsus one and one-half times as long as genu, tapering from mid-length to broadly rounded apex, with one clavate, annulated seta having length equal to two thirds basal width of segment situated dorsally near outer margin at base, one seta two thirds as long as segment located middorsally at basal third, one seta one and one-fourth times as long as segment located on outer margin at apical third, one seta one half as long as segment located on inner margin at mid-segment, one seta two thirds as long as segment located ventrally near inner margin at mid-segment; tarsus surmounted by a narrow pretarsus, length equal to basal width of tarsus, bearing at its tip a broad empodium and two large, spreading, curved claws. Leg III with coxa narrow, elongate, length equal to combined lengths of genu, tibia and tarsus II, greatest width equal to one third length, lateral margins convex for most of their lengths, segment without vestiture; femur as long as combined lengths of genu and tibia II, lateral margins diverging from basal two fifths to apex, outer margin sharply convex at proximal two fifths making segment bulbous basally, segment with three setae; tibia as long as femur, twice as long as broad at base, tapering toward apex, with four setae; tarsus slender elongate, two thirds as long as tibia, sides subparallel, with three setae; tarsus surmounted by a narrow pretarsus, one fourth as long as tarsus, bearing at its tip two large, spreading, curved claws between which projects a broad subcircular empodium. Leg IV with coxa small, subquadrangular, one and one-half times as broad as long, without setae; trochanter short, ringlike, broader than long, without vestiture; third segment narrow, elongate, as long as femur III, about four times as long as broad, sides subparallel, with one ventral seta slightly less than one half as long as segment located near outer margin the width of segment from base, one ventral seta three fifths as long as segment situated near outer margin one third length of seta from apex; fourth segment two fifths as long as third segment, lateral margins tapering slightly to broadly rounded apex, with one stout seta three times as long as segment located dorsally near outer margin at apical third, one terminal seta with length equal to combined lengths of femur and tibia III. *Measurements:* Anterior margin of cephalothoracic shield to apex of hysterosoma, 182μ; main body suture to tip of hysterosoma, 105μ; tips of palpi to main body suture, 103μ; width of body at anterior extremities of coxae III, 106μ; width at main body suture, 97μ.

Holotype: Male, Woodside, San Mateo Co., Calif., June 2, 1949, R. E. Beer, *Quercus lobata* infested with *Asterolecanium minus*.

Allotype: Female, Domoto's Nursery, Hayward, Calif., Sept. 22, 1949, R. E. Beer, *Hydrangea quercifolia*.

Paratypes: Santa Paula, Calif., June 28, 1939, E. W. Baker, lemon bud, (plesiotype male); four males, four females and three larvae (morphotypes) same data as allotype; one female, Santa Paula, Calif., Apr. 25, 1939, E. W. Baker, lemon fruit; one male, Santa Paula, Calif., May 16, 1939, E. W. Baker, lemon fruit; two males, Santa Paula, Calif., June 9, 1939, E. W. Baker, lemon; one male, Domoto's Nursery, Hayward, Calif., Aug. 17, 1949, R. E. Beer, *Hydrangea quercifolia;* one female, Domoto's Nursery, Hayward, Calif., Sept. 26, 1949, R. E. Beer, under bark of *Hydrangea quercifolia.*

Location of types: Holotype, allotype and two males, two females, three morphotypes with same data as allotype, one male from Santa Paula, June 9, 1939, and male from Domoto's Nursery, Sept. 26, 1949, deposited in the Snow Entomological Museum, University of Kansas. All other paratypes in the United States National Museum.

Living specimens of both sexes of this species are jet black in color, a character from which the trivial name is taken. Immature forms as well as young males and females are opaque white with a slight greenish tinge. The species is apparently fungivorous for it was reared through several generations in a container provided with fungus and algae which provided the only source of nourishment for the mites. Specimens collected by this writer were never very abundant. All stages, including eggs, were found in the collection made from under the bark of *Hydrangea quercifolia.*

Genus *Steneotarsonemus,* new genus

This genus is established to include a number of species with considerable similarity in general appearance but rather extensive diversity in specific characters. The males with one exception all have the dorsal propodosomal setae in linear arrangement, the usual number being four pairs; femora IV usually have the inner margins highly modified to form a flangelike process, never with a spurlike projection; the capitulum is usually subcircular, often as broad as or broader than long, never with extremely long palpi. Females never with a conspicuous transverse apodeme near main body suture; body often elongate, with anterior pairs of legs widely separated from posterior pairs; capitulum, as in male, usually as broad as or broader than long; first pair of ventral propodosomal setae usually in front of apodemes I; tracheae often with large conspicuous bilobed pouches or atria situated medially between legs I and II.

Type of genus: *Steneotarsonemus hyaleos,* new species.

In regrouping the mites of the family Tarsonemidae it became evident almost at the onset that a number of species were possessed of an extraordinary resemblance. The most striking feature appeared to be the presence of a highly specialized femur in the males and the common occurrence of an exceptionally elongate body in the females. The members of this genus are all phytophagous and it is remarkable to note in this connection that with the exception of S. *pallidus*, S. *chionaspivorus* and S. *fulgens* the host plants are invariably Monocotyledonae. Within the genus there appears to be some natural grouping, based upon morphological characters, which is again reinforced with host preference. The group including S. *hyaleos*, S. *phyllophorus*, S. *spirifex*, and S. *bancrofti* all feed on plants of the family Gramineae and all bear a very close morphological resemblance. S. *latipes* appears to belong to this group, but the only clue to the feeding habits of this species suggests banana as a host which is in the family Musaceae. S. *laticeps* and S. *ananas* are dissimilar in many respects to the species mentioned above, the hosts of these two being narcissus (Amaryllidaceae) and pineapple (Bromeliaceae), respectively. S. *pallidus* and S. *fulgens* appear to bear the least morphological similarity to other species in the genus. The wide host range of S. *pallidus* and the extraordinary fact that it apparently never feeds on plants in the Monocotyledonae further segregates this species from other members. Biological data on S. *fulgens* is limited due to the fact that at present it is known only from a single collection. S. *chionaspivorus*, it is presumed from collection data available, is apparently the only fungivorous species in the genus.

KEY TO THE MALES OF THE GENUS STENEOTARSONEMUS

1. Femur IV with inner margin produced to form a flangelike expansion 2
   Femur IV without an inner flange 9
2. Propodosoma with four pairs of dorsal setae 3
   Propodosoma with but three pairs of dorsal setae (the setae of second pair missing) .... *phyllophorus*, p. 1244
3. Fourth dorsal propodosomal setae longer than setae of other three pairs; coxae III densely punctate over most of surface . *hyaleos*, p. 1256
   Fourth dorsal propodosomals never longer than setae of other pairs; coxae III never ornamented 4
4. First dorsal propodosomal setae longer than setae of other three pairs; capitulum and legs IV very small compared to large size of idiosoma .... *bancrofti*, p. 1249
   First dorsal propodosomals never longer than remaining three pairs; capitulum and legs IV not disproportionately small compared to dimensions of idiosoma 5

5. First dorsal propodosomal setae shorter than setae of remaining three pairs . . . . *ananas,* p. 1276
   First dorsal propodosomals never the shortest of the dorsal propodosomal setae 6
6. Second dorsal propodosomal setae conspicuously shorter than setae of remaining three pairs 7
   Second dorsal propodosomals nearly as long or longer than other dorsal propodosomals 8
7. Femur IV with inner flange small and somewhat angulate; first ventral propodosomal setae inserted very close to apodemes I; very small mites . . . . *latipes,* p. 1238
   Femur IV with large lobelike inner flange; first ventral propodosomal setae situated well behind apodemes I; mites of moderate size . . . . *spirifex,* p. 1261
8. Tactile seta of tibia IV longer than femur IV; fourth dorsal propodosomal setae shorter than setae of remaining three pairs and not in linear arrangement with the others . . . . *pallidus,* p. 1267
   Tactile seta of tibia IV shorter than femur IV; fourth dorsal propodosomals with length subequal to second setae and only slightly shorter than setae of first pair, all setae in linear arrangement, *fulgens,* p. 1281
9. Tactile seta of tibia IV very short, scarcely longer than segment; longest dorsal propodosomal setae (third) as long as two thirds greatest width of capitulum . . . . *laticeps,* p. 1231
   Tactile seta of tibia IV nearly as long as leg IV; longest dorsal propodosomal setae (third) with length nearly twice greatest width of capitulum . . . . *chionaspivorus,* p. 1285

Steneotarsonemus laticeps (Halbert), new combination

(Plates 6, 18 and 22)

Tarsonemus laticeps Halbert, 1923, Jour. Linn. Soc. London, Zool., vol. 35, p. 381; Breakey, 1943, Washington Agr. Exp. Sta. Bull., 435, p. 116; Ewing, 1939, U. S. Dept. Agr. Tech. Bull., 653, p. 15.

Tarsonemus approximatus narcissi Ewing, 1929, Proc. Ent. Soc. Washington, vol. 31, no. 2, p. 31; Massee, 1933, Ann. Mag. Nat. Hist., London, vol. 10, no. 11, p. 198; Smith, 1935, Jour. Econ. Ent., vol. 28, no. 1, p. 91; Doucette, 1936, Jour. Econ. Ent., vol. 29, no. 6, p. 1103.

Tarsonemus hydrocephalus Vitzthum, 1929, Ent. Tidskr., vol. 50, no. 2, p. 97.

Male: Body short oval, broadest at mid-length; legs short, stout, anterior pairs subequal; apodemes conspicuous; hysterosomal suture distinct, transecting body between coxae III and IV; genital papilla broad, with two apical spinelike processes projecting laterad from apex a distance nearly equal to half width of papilla. Apodemes I as long as width of femur I, extending in posteromedial directions from inner angles of coxae I converging medially slightly behind inner coxal angles of legs I. Anterior median apodeme extending from point of juncture of apodemes I nearly to main body suture, being less distinct posterior from its mid-length. Apodemes II subparallel to apodemes I, extending in posteromedial directions from inner angles of coxae II turning sharply caudad just before juncture with median apodeme, converging on median apodeme less abruptly beyond this point, the point of juncture being just before main body suture. Apodemes III extending in anteromedial directions from anterior condyles of coxae III joining with anterior extremities of apodemes IV, the apodemes defining an area broadly rounded anteriorly, anterior extremities of areas about one fourth distance from main body suture to hysterosomal suture. Apodemes IV strong and distinct, extending from basal angles of coxae IV converging gradually with apodemes III. Posterior median apodeme extending medially from a point just behind posterior extremities of interapodemal areas nearly to hysterosomal suture, apodeme most distinct from mid-length to posterior extremity. Cephalothoracic shield projecting over basal third of capitulum, its anterior margin truncate, as broad as capitulum. *Dorsal chaetotaxy:* Propodosoma with four pairs of dorsal setae ararnged in two longitudinal rows paralleling body margins, the setae of each row being nearly equidistant from each other; setae of first pair as long as combined lengths of tibia and tarsus II, located the length of seta behind anterior margin of cephalothoracic shield, one half length of seta from lateral margins of body, setae of pair separated from each other by a distance slightly greater than their combined lengths; second pair of setae slightly longer than first pair, located four fifths length of seta behind setae of first pair, slightly less than half length of seta from lateral margins of body; third pair of setae nearly three times length of first pair, situated the length of first seta behind second seta, three fourths length of first seta from lateral margins of body; fourth pair of setae very stout, nearly half as long as setae of third pair, located slightly more than one third length of seta behind setae of third pair, about half length of seta from lateral margins of body. Hysterosoma with four pairs of dorsal setae, third pair longer than the others. *Ventral chaetotaxy:* Propodosoma with two pairs of small setae; first pair as long as basal width of tarsus I, located the length of seta laterad from anterior extremity of median apodeme; second pair of setae slightly longer than first pair, located about twice length of seta behind mid-lengths of apodemes II. Hysterosoma with two pairs of ventral setae; first pair as long as tibia III, located near intersections of apodemes III and IV, this location being slightly more than twice length of seta behind main body suture; second pair of ventral hysterosomal setae two thirds length of first pair, located the length of seta laterad from apodemes IV, about in line with anterior extremities of coxae III. *Capitulum:* Length including chelicerae, 39µ; greatest width, 35µ; subcircular, posterior margin rounded with small median indentation. Dorsal setae with length equal to half greatest width of capitulum, located on margins at apical fourth. Ventral setae about one third as long as dorsal setae, separated from each other by distance equal to one and one-half times length of seta. Palpi stout, indistinctly segmented, projecting slightly beyond apex of capitulum. Chelicerae prominent, projecting beyond extremities of palpi; cheliceral sheaths not striate. *Legs:* Leg I with coxa subquadrangular, nearly twice as broad as long, without vestiture; femur as broad as long, tapering from base to apex, with four setae; genu as broad as long, three fourths as long as femur, lateral margins subparallel, with four setae; tibia slightly longer than genu, one and one-fourth times as long as broad at base, tapering from mid-segment to apex, with four normal setae, one tactile seta and two specialized sensory setae, the latter including one short, clavate seta with length equal to one third basal width of segment located dorsally near outer margin at basal third and one rodlike seta with length equal to one third basal width of segment located ventrally on outer margin at basal third; tarsus surmounted by broad empodium beyond which projects tip of strong, curved claw. Leg II with coxa subquadrangular, nearly twice as broad as long, without setae; femur short and broad, slightly longer than greatest breadth, tapered from base to apex, outer margin twice as long as inner margin, with three setae; genu one and one-fourth times as broad as long, tapering slightly from base to apex, with three setae; tibia slightly longer than genu, as broad as long, with four setae; tarsus slightly shorter than tibia, width at base slightly less than length of segment, with four long tactile setae, one stout spine located dorsally near outer margin at basal third, one peglike seta located dorsally near inner margin at basal third and one stout, blunt spine located mid-ventrally just before apex; tarsus surmounted by short broad pretarsus bearing at its apex two stout, curved, spreading claws between and beyond which extends broad, bilobed empodium. Leg III with coxa subtriangular, as long as combined lengths of femur and genu II, posterolateral angle projecting beyond body margin, without vestiture; femur two thirds as long as coxa, twice as long as broad at apex, tapering from base to apex, with one seta; genu as broad as long, with three setae; tibia one and one-third times as long as genu, tapering from distal third to apex, with one broad spine having length equal to one half apical width of segment located dorsally near outer margin at apical third and three tactile setae; tarsus two thirds as long as tibia, one and one-half times as long as broad at base, tapering from base to broadly rounded apex, with three normal setae, one broad spine with length equal to three fourths basal width of segment located ventrally near outer margin at apex and one short, spinelike seta with length equal to half basal width of segment located on outer margin at apex; tarsus surmounted by short, broad pretarsus bearing at its apex two strong, curved, spreading claws between and beyond which projects broad, bilobed empodium. Leg IV with coxa subquadrangular, about one and one-half times as broad as long, outer margin twice as long as inner margin, with one seta; femur short, broad, with length about equal to combined lengths of femur, genu and tibia of leg III, greatest width about equal to half length of segment, inner margin straight for most of its length, outer margin convex, with three setae; tibia as long as tarsus III, outer margin twice as long as inner margin, the latter concave, segment with one rodlike seta two thirds as long as segment situated dorsally on outer margin just before apex and one ventral tactile seta one and one-fourth times as long as segment; tarsus small, about one fourth as long as tibia, twice as broad as long, with three setae; tarsus surmounted by short, broad, slightly curved claw as long as width of tarsus with small notch in outer margin at basal fourth. *Genital papilla:* Length, 33μ; width, 40μ; anterior margin in line with hysterosomal suture, deeply emarginate medially; with two conspicuous, broad, dorsal flaps extending laterally from caudal extremity of papilla, needlelike paired aedeagi with recurved bases in apical third of papilla, their terminal portions projecting laterad from apex of papilla a distance equal to greatest width of femur IV. *Measurements:* Length from tip of capitulum to apex of genital papilla, 183μ; main body suture to apex of genital papilla, 109μ; anterior margin of cephalothoracic shield to main body suture, 55μ; width at main body suture, 91μ; width midway between main body suture and coxae III, 97μ.

Female: Body elongate oval, broadest at point in line with posterior margins of coxae III. Anterior apodemes distinct; posterior apodemes short and inconspicuous. Apodemes I as long as basal width of genu I, converging medially at anterior extremity of median apodeme, their forward extremities at inner coxal angles of legs I. Apodemes II subparallel to apodemes I, extending from inner coxal angles of legs II in posteromedial direction, converging with median apodeme in line with posterior margins of coxae II; apodemes indistinct for a short distance before juncture with median apodeme. Anterior median apodeme well defined from Y-shaped juncture of apodemes I nearly to juncture of apodemes II, disappearing midway between juncture of apodemes II and main body suture. Apodemes III extending medially from anterior condyles of coxae III at nearly right angles to inner margins of coxae, length equal to one third length of coxa III, terminating indistinctly. Apodemes IV inconspicuous, extending anteromedially from points the basal width of tarsus II mesad from inner margins of coxae III at their posterior fourth to points about in line with mid-coxae, these anterior extremities of apodemes III indistinct but separated from median apodeme by distance equal to basal width of tarsus II. Posterior median apodeme indistinct, extending from point in line with anterior extremities of coxae IV to point in line with anterior extremities of apodemes IV. Hysterosoma with six transverse sutures. Cephalothoracic shield short, truncate covering basal fourth of capitulum. Pseudostigmatic organs as long as femur I, expanded apex broadly oval with acute tip, pedicel slender, two thirds as long as expanded apex; basal rings situated midway between coxae I and II. Stigmatal openings distinct, located dorsolaterally the basal width of tibiotarsus I behind anterolateral angles of cephalothoracic shield. *Dorsal chaetotaxy:* Propodosoma with two pairs of dorsal setae; first pair nearly as long as pseudostigmatic organs, located one third length of seta mesad from anterolateral angles of cephalothoracic shield; second pair of setae slightly longer than half width of body at main body suture, located immediately behind pseudostigmatic organs. Hysterosoma with six pairs of dorsal setae all about equal in length, as long as greatest width of coxa III; first pair located on lateral margins of body the length of seta behind main body suture; second pair located three fourths length of seta behind main body suture, twice length of seta from lateral margins of body; third pair in line with anterolateral coxal condyles of legs IV, twice length of seta from lateral margins of body; fourth pair situated on lateral margins of body near anterior margin of penultimate segment; fifth pair of setae nearly in line with fourth pair, separated from each other by distance equal to twice length of seta; sixth pair of dorsal hysterosomal setae located on caudolateral margins of body near base of apical segment. *Ventral chaetotaxy:* Propodosoma with two pairs of minute setae; first pair with length equal to one third basal width of tibiotarsus I, situated slightly behind apodemes I at their mid-lengths; setae of second pair about one and one-half times as long as first pair, located the length of seta behind apodemes II at their mid-lengths. Hysterosoma with first pair of ventral setae slender, elongate, with length equal to greatest width of coxa III, located nearly twice length of seta from main body suture, separated from each other by distance slightly less than their combined lengths; second pair one half length of first pair, situated at posterior extremities of apodemes IV. *Capitulum:* Short and broad; length including palpi, 40μ; greatest width, 43μ; posterior margin rounded truncate with a very small emarginate cleft medially. Dorsal setae with length nearly equal to half greatest width of capitulum, located near lateral margins of capitulum at anterior fifth; ventral setae one third as long as dorsal setae, separated from each other by a distance equal to combined lengths; palpi short, stout, indistinctly segmented. Chelicerae styliform, expanded basally, needlelike apices extending slightly beyond tips of palpi. *Legs:* Anterior pairs short and broad. Leg I with coxa subtriangular, one and one-half times as broad as long, without setae; femur robust, width at base equal to length, tapering from base to apex, with four normal setae; genu two thirds as long as femur, slightly longer than broad at base, tapering from base to apex, with four setae; tibiotarsus one and one-half times as long as genu, tapering to broadly rounded apex, with three modified setae located dorsally on basal fourth of segment, the outermost lanceolate with length equal to half basal width of segment, middle seta of trio capitate with its expanded apical half pitted, length slightly greater than the lanceolate seta, innermost seta located medially on segment peglike, slightly shorter than lanceolate seta, one clavate seta with length equal to half basal width of segment located dorsally near inner margin at apical third, one short, stout, peglike process with lateral margins concave and length equal to one third basal width of segment located mid-ventrally at apex, twelve normal setae; tibiotarsus surmounted by short, narrow pretarsus bearing a broad empodium beyond which projects tip of small curved claw. Leg II with coxa subquadrangular, nearly one and one-half times as broad as long, without vestiture; femur as long as greatest breadth, tapering slightly from base to apex, with three setae; genu slightly broader at base than long, tapering slightly from base to apex, with three setae; tibia slightly longer than broad, as long as genu, lateral margins subparallel, segment with four setae; tarsus nearly as long as tibia, tapering from base to broadly rounded apex, with one short, broad, stout spine with length about one third basal width of segment situated dorsally near inner margin at basal fifth of segment, one clavate seta with length equal to half basal width of segment located dorsally on inner margin at basal fifth, one stout, curved, apical, clawlike spur on outer margin at apical third of segment with length equal to one third length of segment and four normal setae; tarsus surmounted by short pretarsus bearing a pair of short, spreading, curved claws between and beyond which projects a broad empodium. Leg III with coxa narrow, elongate, as long as femur and tibia combined, nearly four times as long as greatest breadth, without vestiture; femur nearly two thirds as long as coxa, basal fourth expanded bulbous, segment with lateral margins divergent from basal third to apex, four setae on segment; tibia three fourths as long as femur, one and one-half times as long as broad at base, lateral margins slightly convex and converging from base to apex, segment with four widely separated setae; tarsus two thirds as long as tibia, nearly twice as long as broad at base, tapering from base to broadly rounded apex, with four setae all situated on apical half of segment and with a short, stout, mid-ventral spur just before apex; tarsus surmounted by a short, broad pretarsus bearing at its apex a pair of stout, curved, spreading claws between and beyond which projects broad empodium. Leg IV with coxa small, subtriangular, nearly one and one-half times as broad as long, without setae; trochanter collarlike, one and one-half times as broad as long, without setae; third segment subcylindrical, tapering slightly from base to mid-segment, sides subparallel from this point to apex, length of segment nearly equal to combined lengths of tibia and tarsus III, with one seta one third as long as segment located ventrally near outer margin one fifth length of seta from base of segment, one stout seta nearly half as long as segment located mid-ventrally slightly less than half length of seta before apex; fourth segment slightly less than half as long as third segment, about three times as long as broad at base, with one stout seta one and one-half times as long as segment located ventrally at apical third of segment, one terminal seta nearly one and one-half times as long as leg IV. *Measurements:* Apex of cephalothoracic shield to tip of opisthosoma, 227μ; tip of shield to main body suture, 82μ; width at main body suture, 98μ; width at anterior condyles of coxae III, 112μ; distance between anterior condyles of coxae III, 68μ.

Types: County Dublin, Ireland, January, abundant in partly decayed narcissus bulbs.

Location of types: Irish National Museum (?).

Material examined by the present writer included specimens with the following data: Males and females, Natividad, Calif., Jan. 28, 1926 and Feb. 6, 1926, C. F. Doucette, narcissus (bearing type labels no. 960 of *T. approximatus narcissi*); San Leandro, Calif., Feb. 6, 1926, C. F. Doucette, narcissus (bearing type label no. 960 of *T. approximatus narcissi*); Bellingham, Wash., Sept. 18, 1928, David Griffiths, narcissus (bearing type label no. 960 of *T. approximatus narcissi*); Castle Hayne, N. C., Jan. 30, 1932, J. T. Sondey, narcissus; Sumner, Wash., Apr. 15, 1933, C. F. Doucette, from *Hippeastrum* in greenhouse; Waterford, Ireland (at Hoboken), Oct. 15, 1942, Limber, narcissus bulbs; Broughshane, Ireland (at Hoboken), Sept. 25, 1942, Limber, on narcissus bulb; Broughshane, Ireland (at Hoboken), Sept. 29, 1942, Limber, on narcissus bulbs; Waterford, Ireland (at Hoboken), Sept. 11, 1922, Limber, narcissus bulbs; Waterford, Ireland (at Hoboken), Sept. 19, 1926, Limber, narcissus bulbs.

This species is one of the two species that are unique as members of the genus as presently constituted in that the male lacks a femoral flangelike expansion on leg IV. However, a consideration of other morphological characters in both sexes has led this author to conclude that S. *laticeps* undoubtedly belongs with this group.

Ewing (1939) presents good evidence in support of the synonymy of *T. approximatus narcissi* Ewing and *T. hydrocephalus* Vitzthum and the present author concurs in the conclusions drawn in the reference cited.

S. *laticeps* is obviously a plant feeder as it has been repeatedly and reliably reported as damaging narcissus bulbs as well as bulbs of other plants in the family Amaryllidaceae. The present writer has collected tarsonemid mites frequently on narcissus bulbs, but in every instance the specimens taken have been *T. setifer*.

Steneotarsonemus latipes (Ewing) new combination

(Plates 7, 18, and 22)

Tarsonemus latipes Ewing, 1939, U. S. Dept. Agr. Tech. Bull., 653, p. 46.

Male: Body short, oval, broadest at anterior condyles of coxae III; legs short, stout, second pair slightly larger than legs I; apodemes conspicuous, well defined; hysterosomal suture distinct. Apodemes I with length equal to half greatest width of capitulum, forming a Y-shaped acute angle at the point of intersection with anterior extremity of anterior median apodeme. Apodemes II extending from inner angles of coxae II in posteromedial directions for a distance equal to greatest width of capitulum, curving slightly caudad at this point and terminating slightly anterior to main body suture, separated at their posterior extremities by a distance equal to basal width of tarsus I. Anterior median apodeme extending from Y-shaped juncture of apodemes I almost to main body suture, becoming indistinct posterior to point in line with inner coxal condyles of legs II. Apodemes III extending from anterior condyles of coxae III in anteromedial directions curving abruptly inward at points one half the distance between their posterior extremities and main body suture, intersecting median apodeme indistinctly. Apodemes IV subparallel to posterior portions of apodemes III, extending from anterior condyles of coxae IV to points of intersection with transverse continuations of apodemes III, the points of intersection slightly laterad from median apodeme, apodemes strongly sclerotized in caudal two thirds of their lengths, weak and indistinct in anterior thirds. Posterior median apodeme extending from juncture with apodemes III to point slightly anterior to inner coxal condyles of legs IV, apodeme strongly sclerotized for the posterior half of its length, indistinct anteriorly. Cephalothoracic shield covering basal half of capitulum its anterior margin truncate, equal to width of capitulum. *Dorsal chaetotaxy:* Propodosoma with four pairs of dorsal setae in linear arrangement, setae of third pair longer than others, setae of second pair shorter than others, first and fourth pairs subequal in length. Hysterosoma with four pairs of dorsal setae. *Ventral chaetotaxy:* Propodosoma with two pairs of ventral setae; first pair located on apodemes I at about their mid-lengths; second pair situated near center of area defined by apodemes II, main body suture and lateral margins of body. Hysterosoma with two pairs of ventral setae; first pair situated near apodemes III at anterior third of apodemes; second pair located on apodemes IV at their posterior thirds. *Capitulum:* Narrow, subcordate with posterior margin emarginate. Dorsal setae with length equal to one third greatest width of capitulum, situated near lateral margins at about mid-length of capsule. Ventral setae slightly longer than dorsal setae, situated at apical fourth of capitulum. Palpi indistinctly segmented, projecting slightly beyond apex of capsule, enclosing short, styliform chelicerae. Length of capitulum including projecting palpi, 21μ; greatest width, 16μ. *Legs:* Short, robust, tapering abruptly from base to apex; legs I and II subequal in size. Leg I with coxa subquadrangular, broader than long, without vestiture; femur with outer margin slightly longer than basal width of segment, inner margin one third as long as outer margin, segment with two setae; genu short, sides converging towad apex, length of segment less than width at base, segment with four setae; tibia slightly longer than broad, sides subparallel and slightly convex, segment with one dorsal, peglike, annulated sensory seta near outer margin at mid-segment and four normal setae; tarsus short, tapering to broadly rounded apex, length equal to basal width, segment terminating ventrally in a stout spurlike process, one clavate, annulated sensory seta with length equal to two thirds basal width of segment, located dorsally near outer margin at basal third of segment, seven normal setae; tarsus terminates in short, narrow pretarsus bearing a broad empodium, nearly as long as tarsus beyond which projects tip of single weak claw. Leg II with coxa subquadrangular, broader than long, without setae; femur slightly longer than basal width, bearing two setae; genu shorter than broad at base, sides converging toward apex, with one stout spine near inner margin at base and three normal setae; tibia slightly longer than broad, sides subparallel, segment with four setae; tarsus as broad at base as long, tapering abruptly to narrowly rounded apex, a ventral spurlike projection on apical margin, segment with one large, clavate, annulated seta situated on inner margin at mid-segment, one short, robust, clavate, sensory peg located dorsally at mid-segment, three normal setae; tarsus surmounted by a slender elongate pretarsus bearing at its apex two strong, curved, spreading claws between and beyond which projects a broad, bilobed empodium. Leg III with coxa broad, subtriangular, sides strongly convex, segment one and one-half times as long as greatest breadth, without setae; femur with inner margin twice as long as outer, segment twice as long as broad, with two setae; genu as long as broad with three setae; tibia nearly one and one-half times as long as broad, with one short, stout, ventral spine near inner margin at mid-segment and three normal setae; tarsus slightly longer than broad at base, tapering abruptly from base to narrowly rounded apex, segment with a strong, ventral, clawlike projection and three setae; tarsus surmountd by short, narrow pretarsus bearing two strong, curved, spreading claws and a broad, bilobed empodium. Leg IV with coxa subtriangular, as broad at apex as long, with one ventral seta; femur short and broad nearly one and one-third times as long as broad at base, inner margin with angular flange occupying apical half of segment, three short setae on segment; tibia narrow, elongate, about one and one-half times as long as broad, sensory seta clavate, tactile seta as long as femur and tibia combined; tarsus one half as long as tibia, broader than long, with three setae subequal in size; tarsus surmounted by short, broad, blunt, curved claw. *Genital papilla:* Length, 30μ; width, 21μ; subcordate with anterior margin emarginate, posterior margin broadly truncate. *Measurements:* Length from tips of palpi to apex of genital pipilla, 132μ; anterior margin of cephalothoracic shield to main body suture, 35μ; width at anterior condyles of coxae III, 75μ.

Female: Body slender, elongate, broadest at mid-length, sides subparallel from main body suture to coxae IV. Apodemes I as long as genu I, extending from inner angles of coxae I to anterior extremity of median apodeme, the anterior angle formed at point of convergence acute. Apodemes II slightly longer than and subparallel to apodemes I, extending from inner coxal angles of legs II almost to median apodeme. Anterior median apodeme extending from Y-shaped juncture of apodemes I to main body suture, most distinct at its anterior fourth and for a short distance near converging extremities of apodemes II. Apodemes III extending in anteromedial directions from anterior condyles of coxae III for a distance equal to two thirds length of coxa III, continuing beyond this point indistinctly. Apodemes IV slightly longer than and subparallel to apodemes III, their posterior extremities near anterolateral angles of coxae IV, anterior extremities near first hysteromal suture and separated from each other at this point by a distance equal to one half basal width of tibiotarsus I. Posterior median apodeme indistinct. Hysterosoma with three conspicuous transverse sutures, one at anterior extremities of coxae III, one at coxae IV, one midway between coxae IV and apex of hysterosoma. Cephalothoracic shield with anterior margin truncate, width of margin equal to greatest width of capitulum. Pseudostigmatic organs with apices broadly oval, pedicels slightly shorter than length of expanded apex. Stigmatal openings distinct, situated dorsolaterally near anterolateral angles of cephalothoracic shield. *Dorsal chaetotaxy:* Propodosoma with two pairs of dorsal setae; first pair with length equal to one half length of tibiotarsus I, situated just behind anterolateral angles of cephalothoracic shield; setae of second pair with length equal to length of capitulum, located near posterolateral angles of propodosoma. Hysterosoma with five pairs of dorsal setae. *Ventral chaetotaxy:* Propodosoma with two pairs of ventral setae; first pair with length equal to length of genu I, located on apodemes I just behind anterior extremities of apodemes; setae of second pair subequal in length to setae of first pair, situated just behind apodemes II at their anterior thirds. Hysterosoma with two pairs of ventral setae; first pair as long as tibiotarsus I, located near anterior extremities of apodemes III, the pair separated from each other by a distance slightly greater than length of seta; setae of second pair slightly shorter than setae of first pair, situated on apodemes IV at about mid-lengths of apodemes. *Capitulum:* Elongate, oval; length including projecting palpi, 23μ; greatest width, 16μ; posterior margin rounded truncate with slight medial emargination. Dorsal setae with length equal to one fourth width of capitulum, located near lateral margins at apical third of capsule. Ventral setae slightly longer than dorsal setae, situated in transverse line with dorsal setae. Palpi robust, indistinctly segmented with one short apical seta and one subapical seta on outer margin. *Legs:* Anterior pairs short and robust, subequal in size. Leg I with coxa subquadrangular, broader than long, without vestiture; femur robust, sides tapering toward apex, with three setae; genu slightly longer than broad, sides subparallel, segment with three setae; tibiotarsus two and one-half times as long as broad at base, sides subparallel for most of the length of segment, apex broadly rounded, segment with one short, stout, clavate, annulated seta and one slightly longer, peglike, sensory seta located dorsally near outer margin at basal third of segment, one long, clavate, annulated seta located dorsally near inner margin at apical third, two short, spinelike setae, three normal setae and two strong, curved, apical setae, segment with an apical clawlike spur located ventrally; tibiotarsus surmounted by a narrow pretarsus bearing at its apex a broad empodium beyond which projects tip of weak, curved claw. Leg II with coxa subquadrangular, broader than long, without setae; femur with length of outer margin equal to width of coxa, inner margin slightly less than half length of outer margin, segment with two setae; genu as broad at base as long, tapering slightly toward apex, with three setae; tibia as long as genu, one and one-half times as long as broad, sides subparallel, with three short and one long tactile setae; tarsus short, as broad at base as long, tapering abruptly to broadly rounded apex, segment with one long, clavate, annulated seta nearly as long as segment located dorsally near inner margin at mid-segment, one short, peglike, annulated seta located ventrally near inner margin at about mid-segment, one long tactile seta and two short setae, tarsus bearing ventrally at its outer apical margin a short spurlike projection; tarsus surmounted by a short pretarsus bearing two small, curved claws between which projects a broad empodium. Leg III with coxa slender, elongate, as long as combined lengths of genu and tibiotarsus I, without vestiture; femur two thirds as long as coxa, basal third bulbous, apical two thirds of segment with sides diverging from constriction at basal third to broad apex, segment with three ventral and one dorsal setae; tibia as long as femur, lateral margins convex, with four setae; tarsus slender, elongate, two thirds as long as tibia, with two normal and one elongate tactile setae; tarsus surmounted by slender, elongate, bilobed pretarsus bearing at its apex two curved, spreading claws between and beyond which projects broad empodium. Leg IV as long as leg III, with coxa small, subquadrangular, as broad as long, without setae; trochanter small, one and one-half times as broad as long, without setae; third segment slender, elongate with sides subparallel for entire length, segment approximately eight times as long as broad, with one seta one sixth as long as segment located ventrally at base of segment, one seta as long as basal seta situated ventrally at apical sixth of segment; fourth segment two fifths as long as third segment, sides slightly divergent toward apex, with one short, stout, ventral seta slightly toward apex from mid-segment, its length equal to one and one-fourth times length of segment, one terminal seta one and one-half times the length of leg IV. *Measurements:* Apex of cephalothoracic shield to tip of opisthosoma, 126μ; tip of shield to main body suture, 52μ; width at main body suture, 49μ.

Types: Material originating in Colombia, South America, intercepted at New York City, New York, Sept. 20, 1934, F. O. Dodd, in banana debris.

Location of types: U. S. National Museum. One male specimen from the cotype series, identified by U.S.N.M. No. 1133-A is hereby designated lectotype.

Specimens examined by the present writer included all mites in the type series including males and females taken by F. O. Dodd from an unidentified leaf in banana debris from Colombia, at New York City, on September 20, 1934. The type slide was broken down and the mites were mounted individually on separate slides. Critical examination of specimens indicates that Ewing's (1939) observation of a hyaline expansion on the outer margin of the male tibiotarsus IV was in error, as such an expansion does not exist. Also, in the same reference, Ewing remarks on the unusual ventral placement of the subapical seta of the terminal segment in leg IV of the female. Such placement was found in the present study to be the usual position in all species studied. The most striking features of this species are here noted as the small size, as compared to other members of the genus, and the long, narrow capitulum.

Steneotarsonemus phyllophorus (Ewing), new combination

(Plates 4, 17 and 22)

Tarsonemus phyllophorus Ewing, 1924, Proc. Ent. Soc. Washington, vol. 26, no. 3, p. 66; Ewing, 1939, U. S. Dept. Agr. Tech. Bull., 653, p. 47.

Male: Body short and broad, diamond-shaped, tapering abruptly to anterior and posterior from coxae III. Rostral shield truncate at apex. Main body suture distinct, transecting body between coxae II and anterior margins of apodemes III. Leg I apodemes short, length equal to width of genu I, converging with anterior median apodeme opposite bases of femora of legs I. Leg II apodemes distinct, converging on anterior median apodeme opposite middles of bases of coxae II, median apodeme decreasing in distinctness from this point to main body suture. Apodemes of legs III and IV converging anteriorly just behind main body suture, forming well defined areas which are sharply rounded anteromedially and broad at bases of coxae III. Posterior median apodeme indistinct except at its anterior extremity where it is visible as a three-tined fork, one medial tine, the other two diverging anteriorly, times subequal in length, as long as width of tarsus I, median apodeme becoming indistinct posterior to base of tines, this conspicuous portion of apodeme located medially in line with anterior condyles of coxae III, apodeme with two divergent forks just before apex of body each directed caudolaterally, terminating at inner apical angles of coxae IV. *Dorsal chaetotaxy:* Three pairs of setae on propodosoma; anterior pair small, length equal to width of tarsus I, located in line with anterior extremity of median apodeme the length of leg I apodeme laterad from mid-line; second setae quite long, tapering to threadlike tip, as long as leg I from base of femur to apex of tarsus, situated one half width of tarsus I from base of coxa II, in line with juncture of apodemes II and median apodeme, this pair of setae separated from each other by a distance equal to length of seta; third pair of setae long and broad, as wide for most of their lengths as basal diameter of second setae, length of setae equal to combined lengths of femur and genu I, situated half length of seta immediately behind second setae and about one third length of seta in front of main body suture. Four pairs of setae on hysterosoma; anterior pair as long as distance from basal condyle of coxa III to main body suture, situated near lateral margins of body one half width of tibia I in front of basal condyles of coxae III; second pair of hysterosomal setae with length equal to half width of capitulum, situated on apodemes IV one third length of apodeme from its posterior extremity; third pair of hysterosomal setae about as long as first pair, located opposite inner margins of coxae IV, about one half seta length anterior to front margin of genital papilla and in line with lateral margins of papilla at its broadest point; fourth pair of setae slightly shorter than third pair, situated beside genital papilla in line with base of anterior cleft of papilla, one sixth width of papilla from its lateral margin. *Ventral chaetotaxy:* Four pairs of setae on venter of body, two pairs on propodosoma, two pairs on hysterosoma; first pair small, length equal to width of tarsus I, located seta length laterad from anterior extremity of median apodeme; second pair with length equal to length of tarsus I, one and one-half times length of seta from median apodeme in line with juncture of apodemes II and median apodeme; first pair of hysterosomal setae as long as width of femur II at apex, located midway between basal condyles of coxae III and mid-body in line with this condyle, in apical third of interapodemal area; second pair of hysterosomal setae of same length as first pair, situated close to apodemes IV at basal fourth of interapodemal area, this pair of setae thus being almost in line with juncture of three short forks of forward extremity of posterior median apodeme. *Capitulum:* Length including projecting palpi, 36μ; width, 36μ; cordate with posterior margin emarginate; a pair of ventral setae at bases of palpi; one pair of dorsolateral setae opposite bases of palpi; apical segment of palpus with minute subterminal bristle on outer margin. *Legs:* Anterior pair slightly longer than second pair, both pairs with five segments, front legs terminating in single claw, second pair with two claws, both with large empodia; coxae and genua of legs I and II broader than long, remaining segments longer than broad. Legs III very large, nearly as long as breadth of body at coxae III; coxae two thirds as broad at apex as long, the former dimension equal to length femur II; femur twice as long as broad, inner margin indented at mid-segment; genu broader than long; tibia almost twice as long as broad; tarsus tapering from base to apex, terminating in two strong claws and a broad empodium. Legs IV reduced in length, greatly expanded in breadth; coxa subquadrangular, broader than long, with a single seta situated near mid-segment; femur twice as long as tibia III, with a broad, rounded, membranous inner expansion, extending from near apex of segment nearly four fifths its length, segment with three setae, one located near inner margin of femur proper, one third length of segment from apex, seta as long as genu III, another seta with size subequal to former, situated on inner margin of femur proper at base of femoral flange, remaining seta on outer margin of segment, longer than inner femoral setae but not as thick and located at mid-segment; tibia short, length equal to one half width of tibia III, one half as broad as long, with one long tactile seta and one short, spinelike seta, the former dorsal in position and slightly longer than outer femoral seta, as long as segment, located dorsally on outer margin near apex; tarsus shorter than tibia, with two minute bristles on inner margin, one seta on outer margin; claw reduced to a minute knob. *Genital papilla:* Length, 32μ; width, 46μ; subcordate, broadly truncate at apex. *Anal plate:* Small, pyriform, twice as long as broad, length equal to length of tarsus I, two minute apodemes extending forward from anterolateral margins of central disc, two midlateral apodemes, all four extending forward from disc forming acute angles. *Measurements:* Length from tip of rostrum to apex of genital papilla, 173μ; width at coxae III, 125μ; tip of rostral shield to main body suture, 63μ; width of body at main body suture, 96μ; length of body including capitulum, 190μ.

Female: Body narrow, elongate, sides subparallel for most of their length; main body suture distinct, transecting body nearly midway between posterior extremities of legs II and bases of coxae III; four transverse sutures behind main body suture. Apodemes I and anterior median apodeme distinct, the former converging medially opposite middles of coxae I; apodemes II indistinct, extending from inner angles of coxae II in posteriorly converging lines which disappear in area midway between inner coxal angles and median apodeme, the latter disappearing slightly behind posterior angles of coxae II. Posterior apodemes short, those of legs III about one half as long as coxae III, extending anteriorly from bases of coxae III in slightly converging lines; apodemes IV parallel, as long as width of tibia II, extending forward from anterior angles of coxae IV. Genital cleft in posterior half of penultimate segment furcate caudally enclosing area as wide as tibia III. Pseudostigmatic organs prominent, on narrow pedicels as long as expanded tips, the latter egg-shaped, one and one-half times as long as broad; basal plates subcircular, irregular in outline, diameter equal to width of apical club, situated laterally midway between coxae I and II. Tracheal openings prominent, located at anterolateral angles of rostral shield slightly anterior to first pair of dorsal propodosomal setae. Tracheae clearly visible, converging medially near mid-length of anterior median apodeme, here forming two prominent bilobed expansions. *Dorsal chaetotaxy:* First pair of setae two thirds length of capitulum, situated one half length of seta behind anterolateral angles of rostral shield; second pair of setae twice as long as legs II, located immediately behind bases of pseudostigmatic organs the basal width of tarsus II from lateral margins of body; third pair of setae one third length of coxae III, located two thirds length of seta from lateral margins of body midway between anterior extremities of apodemes III and main body suture; fourth pair of setae one fourth as long as coxa III, located the width of tarsus II anterior to basal condyles of legs III, slightly mesad to these condyles; fifth pair of setae one half length of coxa IV, situated at inner margins of femora III; sixth and seventh pairs of setae in transverse line, both pairs of equal lengths, as long as basal width of femur III, outer pair on lateral margins of body, distance between inner pair slightly greater than distance between inner and outer setae, all four setae alligned on anterior fourth of penultimate hysterosomal segment; eighth pair of setae one and one-half times as long as setae of seventh pair, situated on anterolateral margins of apical hysterosomal segment. *Ventral chaetotaxy:* First pair of setae one half as long as width of tibiotarsus I, located the length of seta mesad to inner angles of coxae I, half length of seta anterior to apodemes I; second pair of setae with length equal to width of tarsus I, situated the length of seta from anterior median apodeme slightly behind inner angles of coxae II; third pair of setae one half length of coxae III, located about midway between anterior extremities of apodemes III and mid-body, setae separated from each other by a distance equal to three fourths length of coxa III; fourth pair of setae with length equal to one half length of setae of third pair, situated opposite distal thirds of coxae III one and one-half times length of seta from inner margins of coxae, separated from each other by a distance equal to length of coxa III; fifth pair of setae with length equal to basal width of femur III, located near apex of body, projecting beyond apex for half their lengths, separated from each other by a distance equal to length of femur III. *Capitulum:* Length, 32µ; width, 32µ; subcordate in outline, posterior margin emarginate; one pair of dorsolateral setae as long as tarsus I located at anterior third of head capsule, projecting forward beyond apex. Palpus two-segmented with a short, ventral seta near inner margin of basal segment and a small subterminal bristle on outer margin of apical segment. *Legs:* Both anterior pairs short, front legs slightly longer than legs II. Leg I three times as long as breadth of coxa at base; coxa broader than long, without setae; femur one and one-half times as long as broad, its outer margin incurved at base and nearly twice as long as inner margin, four setae on segment; genu as broad as long, with four setae; tibiotarsus twice as long as broad at base terminating in a single, stout claw projecting beyond large, bilobed empodium, segment with three clavate setae and eleven normal setae. Leg II twice as long as basal width of coxa; coxa broader than long, subtriangular shape, without setae; femur slightly longer than broad, outer margin long, slightly concave, inner margin short, straight, segment with three setae; genu one and one-half times as broad as long, with three setae; tibia one and one-half times as long as broad, with four setae; tarsus as broad as long, tapering from base to apex which is surmounted by two prominent, spreading claws with a broad empodium projecting beyond, segment with two short, clavate setae and four normal setae. Leg III with coxa narrow, elongate, slightly more than four times as long as broad, its outer margin parallel to sides of body; femur three fifths as long as coxa, lateral margins diverging apically, segment with three setae; tibia twice as long as broad, tapering slightly to apex, with four setae, all on distal half of segment; tarsus twice as long as broad at base, tapering to bluntly rounded tip beyond which is pair of prominent, spreading claws and broad, projecting empodium, segment with four setae one of which is more than than twice as long as combined lengths of tarsal segment and its terminal appendages. Leg IV with coxa about as broad as long, triangular in shape; trochanter broader than long, subtriangular, collarlike; third segment slender, elongate, as long as distance between inner angles of coxae II, segment with two setae, one near outer margin at base of segment one and one-half times as long as width of segment at base, other seta ventral at apical fifth of segment, extending one third its length beyond tip of segment; fourth segment narrow, two fifths as long as third segment, terminating in two setae, one apical the other subapical, the latter stout, twice as long as segment, situated the width of segment before apex, terminal seta long, slender, twice as long as segments three and four combined. *Measurements:* Length from tip of capitulum to apex of hysterosoma, 327μ; tip of rostral shield to tip of hysterosoma, 312μ; front margin of rostral shield to main body suture, 80μ; width at main body suture, 106μ; width at anterior condyles of coxae III, 120μ.

Types: Brooksville, Florida, Feb. 3, 1931, W. B. Wood, bamboo. The type slide mounts about fifty specimens, one male of which has been encircled by the present writer and which is hereby designated lectotype.

Location of types: United States National Museum No. 23777 (insect book).

Material examined contained the following data: Brooksville, Florida, Feb. 3, 1921, W. B. Wood, bamboo (Type slide, no. 23777, containing approximately fifty specimens of both sexes); Brooksville, Florida, Feb. 18, 1924 and Feb. 19, 1924, W. T. Owrey, *Phyllostachys bambusoides;* Brooksville, Florida, Feb. 12, 1922, H. L. Sanford, *Phyllostachys bambusoides;* Yokahama, Japan, Nov. 27, 1922, *Phyllostachys quinoi;* Savannah, Georgia, Dec. 18, 1944, Rau, *Phyllostachys bambusoides.*

This species is quite distinctive, particularly in the males. The extreme angular shape of the body, the robust legs and the three, rather than four, pairs of dorsal propodosomal setae readily differentiate the male from other members of the genus. In comparing characters of this sex only, *S. phyllophorus* seems to be most closely related to *S. bancrofti.*

Steneotarsonemus bancrofti (Michael), new combination

(Plates 3, 17 and 22)

Tarsonemus bancrofti Michael, 1890, Roy. Bot. Gard. Kew, Bull. Misc. Info., no. 40, p. 85; Rutherford, 1913, Trop. Agr. Peradeniya, vol. 41, no. 6, p. 490; Banks, 1915, U. S. Dept. Agr. Rept., 108, p. 108; Annand, 1943, U. S. Dept. Agr. Bur. Ent. and Plant Quarantine Rept., 1942-43, p. 12; Ewing, 1939, U. S. Dept. Agr. Tech. Bull., 653, p. 38.

Tarsonemus spinipes Hirst, 1912, Bull. Ent. Res., vol. 3, p. 325; Jones, 1914, Jour. Econ. Ent., vol. 7, no. 6, p. 461; Bianchi, 1940, Proc. Hawaiian Ent. Soc., vol. 10, no. 3, p. 375.

Male: Body short and broad, diamond-shaped, broadest at coxae III, tapering abruptly to posterior, less abruptly to anterior. Rostral shield broadly, angularly truncate at apex, width of apex slightly greater than width of capitulum. Main body suture distinct, transecting body one fourth distance from hind angles of coxae II to anterior condyles of coxae III. Posterior body suture transecting body at anterior angles of coxae IV, distinct for most of its length. Anterior apodemes distinct, those of legs I extending from inner angles of coxae I to point of convergence medially in line with hind angles of coxae I; median apodeme extending from point of convergence of apodemes I to point in line with hind angles of coxae II, becoming less distinct from anterior to posterior; apodemes II extending from inner angles of coxae II in posteromedial directions, turning abruptly caudad three fourths distance from inner angles of coxae II to median apodeme, converging to point of juncture just before hind extremity of median apodeme. Posterior apodemes distinct, those of legs III extending in anteromedial directions from anterior condyles of coxae III; apodemes IV subparallel to apodemes III, extending forward from anterior angles of coxae IV; apodemes III and IV converging anteriorly, enclosing a broad area terminating anteriorly slightly behind main body suture; median apodeme with anterior extremity in line with anterior condyles of coxae III, extending caudally to point opposite hind margins of coxae IV, broadly expanded at this point. *Dorsal chaetotaxy:* Four pairs of setae on propodosoma, third pair much longer than others; anterior pair as long as tibia I, separated from each other by distance equal to half length of seta, located slightly more than length of seta behind anterior margin rostral shield; second pair one and one-half times as long as first pair, separated from each other by a distance equal to half length of seta, located one third length of seta behind and slightly laterad to first pair; third pair slightly more than twice length of second pair, separated from each other by a distance equal to width of capitulum, setae located one half length seta of second pair behind and slightly laterad to these setae, in line with anterior angles of coxae II; fourth pair of setae twice length of first pair, situated midway between third pair and main body suture. Four pairs of dorsal setae on hysterosoma; first pair slightly longer than fourth pair of propodosomal setae but not as thick, located one third length of seta from lateral margins of body, slightly anterior and medial to basal condyles of coxae III; second and third pairs subequal in length, as long as second pair of propodosomal setae, situated in transverse row in line with posterior thirds of coxae III, inner pair separated from outer pair by a distance equal to two thirds length of seta and separated from each other by a distance equal to one and three-fourths times length of seta, outer pair situated one fourth length of seta medial to inner margins of coxae III; fourth pair of dorsal hysterosomal setae with length equal to basal width of tibia III, situated at lateral margins of genital papilla, about one fourth distance from anterior to posterior extremities of papilla. *Ventral chaetotaxy:* Propodosoma with two pairs of minute setae; first pair as long as width of tarsus I, situated one and one-half times length of seta laterad from point of juncture of apodemes I; second pair slightly longer than first pair, situated two and one-half times length of seta laterad from point of juncture of apodemes II. Hysterosoma with two pairs of ventral setae; first pair elongate, threadlike, length equal to length tibia II, located one and one-half times length of seta from lateral margins of body, two thirds length of seta behind main body suture, thus being in outer anterior portion of interapodemal area delimited by connected anterior extremities of apodemes III and IV; setae of second pair minute, as long as apical width of tibia III, located one half length of seta laterad from apodemes IV at their mid-lengths. *Capitulum:* Length, 40μ; width, 39μ; subcordate, with posterior margin emarginate, each lobe sharply pointed medially. Dorsolateral setae long, extending slightly beyond apices of palpi; ventral setae as long as apical width of tibia I. Palpi short and broad, projecting slightly beyond apex ot capitulum, subapical bristles conspicuous. Chelicerae short, needlelike, projecting between palpi. *Legs:* Legs II larger than legs I, distance between coxae I and II equal to width of tibia II. Leg I with coxa subquadrangular, nearly twice as broad as long, inner margin greatly convex, segment without vestiture; femur twice as long as broad, outer margin incurved basally, segment with three setae; genu one half length of femur, slightly longer than broad at base, tapered from base toward apex, segment with four setae; tibia slightly longer than genu, tapering slightly from mid-segment to apex, with five normal setae and three short, sensory pegs located dorsally side by side near outer margin at about basal third of segment, the middle peg clavate, its length equal to half apical width of segment, inner peg clavate and three fourths length of middle peg, outer peg pointed apically and one half length of middle peg; tarsus one and one-half times as long as broad, tapered slightly to broadly rounded apex, with six normal setae and one clavate seta, the latter with length equal to one half length of segment, located dorsally near outer lateral margin at basal third of segment; broad empodium extends beyond tarsus a distance equal to length of tarsus; tip of single curved claw projects beyond empodium. Leg II with coxa subquadrangular, nearly twice as broad as long, without setae; femur only slightly longer than femur I but much broader, segment as long as combined lengths of genu and tibia I, breadth equal to length of tibia I, with three minute setae; genu slightly longer than broad, tapered slightly from base to apex, with three setae; tibia twice as long as broad at base, tapered slightly from mid-segment to apex, with four setae; tarsus one and one-half times as long as broad at base, tapering to narrowly rounded apex, with four normal setae, one clavate seta having length equal to basal width of segment situated dorsally near outer margin at basal fourth of segment, one short, clavate seta one half as long as the former situated dorsally near outer margin at basal third of segment, one short, peglike seta with length equal to half basal width of segment located ventrally near outer margin at mid-segment; tarsus surmounted by two large, spreading, curved claws beyond and between which projects a broad empodium. Leg III with coxa subtriangular, one and one-half times as long as broad, length equal to distance between posterior condyle of coxa II and anterior condyle of coxa III, segment without vestiture; femur twice as long as broad, width at apex slightly less than width at base, basifemur partially separated from remainder of segment by a suture, segment with one seta; genu one and one-half times as long as broad, two thirds as long as femur, sides subparallel, with three setae, one of which is stout and spinelike; tibia twice as long as broad at base, tapering from mid-segment to apex, with four setae, one of which is stout and spinelike; tarsus twice as long as broad at base, tapering from base to narrowly rounded apex, with three setae; tarsus surmounted by a pair of strong, spreading, curved claws between and beyond which extends a broad empodium. Leg IV with coxa slightly longer than broad, as long as femur I, outer margin convex, with one seta; femur about one and one-half times as long as coxa, outer margin slightly convex, sclerotized portion of inner margin straight, width at mid-segment not including flange equal to width of genu III, inner flange occupying apical two thirds of inner margin of segment, broadest opposite apical one fourth of segment, its width at this point equal to greatest width of segment, with one stout bristle having length nearly equal to width of segment located ventrally at middle of base of flange, one normal seta with length equal to width of segment located ventrally at basal juncture of flange with sclerotized portion of segment, one small seta two thirds as long as width of segment situated dorsolaterally on outer margin at apical fourth of segment; tibia one and one-half times as long as broad at base, length equal to two thirds width of femur, outer lateral margin nearly twice as long as inner margin, with one stout seta two thirds as long as femur situated ventrally near outer margin at mid-segment, one short stout bristle with length equal to one half basal width of segment located on outer margin at apex of segment; tarsus subtriangular, inner margin twice as long as outer margin, segment as broad as long, length about equal to basal width of tarsus III, segment with numerous, small, irregular tubercles, with one minute bristle on dorsal and ventral surfaces of inner margin at about mid-segment, one small dorsal seta on outer margin; tarsus terminated by a short, stout, curved claw only slightly longer than broad at base. *Genital papilla:* Length, 47μ; width, 48μ; subcordate, with anterior margin deeply emarginate, posterior margin bluntly rounded. *Anal plate:* Central disc as long as apical width of tibia III, broadly rounded at anterior extremity, tapering to narrowly rounded posterior; two diverging hornlike apodemes extending from broadest point in anterolateral directions a distance equal to width of disc. *Measurements:* Tips of palpi to apex of genital papilla, 301μ; length from tip of cephalothoracic shield to apex of genital papilla, 264μ; width of body measured from outer margins of coxae III, 174μ; tip of rostral shield to main body suture, 119μ; width of body at main body suture, 140μ; length from main body suture to posterior body suture, 90μ.

Female: Body elongate oval, broadest between main body suture and anterior condyles of coxae III. Anterior apodemes distinct, those of legs I extending from inner angles of coxae I, converging medially in line with posterior extremities of coxae I; median apodeme extending caudad from juncture of apodemes I to point in line with posterior condyles of coxae II; apodemes II extend diagonally from inner angles of coxae II to median apodeme. Posterior apodemes distinct, apodemes III extending in anteromedial directions from anterior condyles of coxae III, their lengths equal to two thirds length of coxa III, anterior third of apodemes parallel to lateral margins of body; apodemes IV one and one-half times as long as width of coxa III, directed anteromedially from posterior extremity at half length of apodeme mesad to inner margin of coxa III at posterior third of segment. Genital cleft occupying entire penultimate segment, caudal extremity of cleft expanded. Pseudostigmatic organs as long as tibiotarsus I, on short, thin pedicels, one half length of broad ovoid apices, the latter twice as long as broad, width equal to one-half width of femur I, organs mounted on ringlike basal plates with diameters equal to width of expanded apices of organs, located a distance equal to diameter behind posterior extremity of coxa I. Tracheal openings distinct as a pair of small sclerotized rings, situated at anterolateral angles of rostral shield, tracheae converging posteriorly forming two sclerotized, elongate, bilobed structures located midway between inner angles anterior pairs of legs, tracheae indistinct behind these structures. *Dorsal chaetotaxy:* Two pairs of dorsal setae on propodosoma; first pair with length equal to width of femur I, located about the length of seta behind anterolateral angles of rostral shield; second pair with length about equal to length of leg I, located above and slightly behind basal rings of pseudostigmatic organs. Six pairs of dorsal setae on hysterosoma; first pair of setae with length equal to length of femur II, located one and one-half times length of seta from lateral margins of body directly above anterior extremities of apodemes III; second pair of setae small, length equal to length of genu II, located the length of seta from lateral margins of body, slightly anterior to previous pair of setae; third pair of setae with length equal to width of tarsus III, located the length of femur III from lateral margins of body in line with posterior fifths of coxae III; fourth pair of setae with length subequal to third pair, located the length of femur III behind and slightly mesad to hind extremities of coxae IV, separated from each other by a distance equal to four times length of seta; fifth and sixth pairs setae arranged in transverse row on anterior margin penultimate segment, subequal in length, one and one-half times as long as basal width of tarsus III, outer pair near lateral margins of body, inner pair separated from each other by distance equal to three times length of seta. *Ventral chaetotaxy:* Two pairs of setae on propodosoma; first pair minute, one fourth as long as basal width of tibiotarsus I, located at junctures of apodemes I with inner angles of coxae I; second pair of setae as long as width of genu II, located one and one-half times length of seta laterad from juncture of apodemes II with median apodeme. Three pairs of ventral setae on hysterosoma; anterior pair with length equal to one half length of coxa III, located slightly medial to anterior extremities of apodemes III; second pair with length equal to width of coxa III, located at hind extremities of apodemes IV; third pair of setae stout, length equal to width of trochanter IV, located at apex of body, separated from each other by distance equal to twice length of seta. *Capitulum:* Length, 40μ; width, 39μ; subcordate, caudal margin truncate, anterior margin bluntly rounded, with chelicerae and palpi projecting slightly beyond apex. Dorsolateral setae more than half length of capitulum; palpi normal, indistinctly segmented. *Legs:* Anterior pairs short. Leg I with coxa subquadrangular, broader than long, without setae; femur one and one-half times as long as broad, outer margin incurved basally, with three setae; genu almost one and one-half times as long as broad at base, tapering slightly from mid-segment to apex, with four setae; tibiotarsus nearly three times as long as broad at base, tapering slightly to broadly rounded apex, an indistinct transverse suture partially dividing segment at apical third, with three specialized sensory setae and ten normal setae; tibiotarsus terminating in narrow pedicel, its length equal to one half basal width of segment, from apical extremity of which projects a single, strong, curved claw as long as pedicel and a broad, oval empodium. Leg II with coxa subquadrangular, nearly twice as broad as long, without vestiture; femur twice as long as broad at apex, outer margin incurved at basal half of segment, with three setae; genu as broad as long, with one stout, pointed, dorsal peg one half as long as segment, situated on inner margin at basal fourth of segment, one seta slightly longer than segment located ventrally near outer margin at basal third, one short, stout, pointed peg one half length of segment situated ventrally on inner margin at midsegment; tibia one and one-half times as long as broad at base, tapering slightly from base to apex, with four setae; tarsus about as broad as long, tapering abruptly to narrowly rounded apex, with one clavate seta one half as long as segment located middorsally at basal third, one short, stout, pointed seta situated dorsally near outer margin at basal fourth, one short, peglike seta one third as long as segment situated on outer margin at apical third, four normal setae; tarsus surmounted by short, narrow pedicel bearing two strong, curved, spreading claws apically, a large empodium projecting between claws. Legs III situated well behind legs II, with coxa narrow, elongate, sides parallel to body margins, about four times as long as greatest breadth, length equal to combined lengths of femur, genu and tibia of leg II, segment without ornamentation; femur about three and one-half times as long as broad at apex, lateral margins diverging from basal third to apex, with three setae; tibia two and one-half times as long as broad, sides subparallel, with four setae; tarsus about two thirds as long as tibia, three times as long as broad at base, slightly narrowed at mid-segment, with four setae; tarsus surmounted by a pair of strong, curved, spreading claws between and beyond which extends a broad empodium. Leg IV with coxa small, subquadrangular, slightly longer than broad, without vestiture; trochanter collarlike, as broad as long; third segment elongate, cylindrical, sides parallel, length equal to combined lengths of tibia and tarsus III, width one half width of tibia III, one seta with length equal to width of segment, located ventrally near inner margin one half length of seta from base of segment, one seta with length equal to two and one-half times width of segment, situated ventrally near inner margin, one half length of seta from apex of segment; fourth segment about three times as long as broad, one fourth as long as third segment, with one long, stout, ventral seta having basal diameter equal to one half width of segment, its length equal to two and one-half times length of segment, one apical seta twice as long as leg. *Measurements:* Length from tip of capitulum to apex of abdomen, 328μ; tip of rostral shield to tip of abdomen, 290μ; front margin of rostral shield to main body suture, 90μ; width at main body suture, 88μ.

Types: Australia, on *Saccharum officinarum.*

Location of types: Unknown.

Material examined included specimens with the following data: Canal Point, Fla., May 16, 1922, E. W. Brandes, in sugarcane stalk; Arlington Farm, Va., Feb. 5, 1935, R. D. Rands, on sugarcane; Arlington, Va., Feb. 11, 1935, F. F. Smith, sugarcane in greenhouse; Experiment Sta., Houma, La., Oct. 10, 1935, J. W. Ingram, on sugarcane; Vicosa, Brazil, Nov. 8, 1932, E. J. Hambleton, on sugarcane; Tahiti, Society Islands (at Wash. D. C.), Sept. 29, 1936, D. P. Limber, on *Saccharum officinarum.*

It appears that this species occurs wherever sugarcane grows. To date it has been completely host specific, this writer being cognizant of no records of specimens taken from any host other than *Saccharum officinarum.*

The species was first described by Bancroft (1877), but this author neglected to identify it with a name. In 1890 Michael proposed the name *Tarsonemus bancrofti* and as a description referred to the rather complete one supplied earlier by Bancroft. The present writer is in complete agreement with Ewing (1939) in his refutation of Hirst's (1912) claim that Bancroft's description was not accurate enough for proper identification, a claim upon which he based his right to propose the species *Tarsonemus spinipes.* This latter name has since been duly recognized by most workers as a synonym for *S. bancrofti.*

Steneotarsonemus hyaleos, new species

(Plates 1, 5, 17 and 22)

Male: Body elongate oval, tapering from main suture body to capitulum, sides subparallel between coxae III and main body suture, bluntly rounded caudad from coxae III. Main body suture and posterior body suture distinct, the latter transecting body at posterior extremities of coxae III. Apodemes of legs I converging abruptly with median apodeme which extends to converging apodemes of legs II, these terminating at a point about one half distance from juncture of apodemes I to main body suture. Apodemes of legs III and IV converging indistinctly, defining an area broadest at anterior extremities of coxae III. Posterior median apodeme distinct, extending from tip of body to forward extremities of apodemes of hind legs; apodemes of legs IV closing indistinctly with median apodeme anteriorly at point the length of coxa III behind main body suture. Venter of body minutely, densely and indistinctly punctured in area in front of anterior terminations of posterior apodemes. *Dorsal chaetotaxy:* Three pairs of strong setae on anterior half of propodosoma, middle pair slightly weaker than others, all three pairs arranged equidistant from converging lateral margins of propodosoma and nearly equidistant from each other; fourth pair of dorsal propodosomal setae twice as long as setae of first pair, located behind third pair a distance equal to distance between first and third pairs; hysterosoma with four pairs of dorsal setae. *Ventral chaetotaxy:* Two pairs of ventral setae on propodosoma; first pair minute, located the width of tarsus I from midline, opposite juncture of apodemes I; second pair small, situated near centers of areas defined by apodemes II, inner bases of coxae II and main body suture. Two pairs of ventral hysterosomal setae; first pair rather prominent, situated slightly behind and equidistant from united anterior extremities of apodemes III and IV; second pair subequal in length to first pair, located within area defined by apodemes III and IV, situated very close to apodemes IV one third length of apodeme from junction of apodeme with basal condyle of coxa IV. *Capitulum:* Subcordate, with posterior margin emarginate; length including projecting palpi, 29μ; greatest width, 24μ. Dorsal setae with length equal to two fifths width of capitulum, located near outer margins at apical third, separated from each other by their combined lengths. Ventral setae one half as long as dorsal setae, situated at apical third of capitulum, separated from each other by their combined lengths. Palpi indistinctly three-segmented, projecting, apical segment with a minute subterminal bristle and a minute lateral bristle near base. Chelicerae short, needlelike, extending to tips of palpi. *Legs:* Anterior pairs subequal, short, most segments broader than long; empodia large, projecting beyond claws, each of the four anterior tarsi with one clavate, sensory seta, remaining segments of four anterior legs without clavate setae. Leg III short and broad, with coxa coarsely, densely punctured, less than one and one-half times as long as broad; empodium prominent; clavate sense setae absent on leg III. Leg IV with coxa as broad as long, a single seta on ventral surface at posterolateral angle; femur nearly twice as long as width at base, inner and outer margins strongly convex, the former with a nearly square, flangelike expansion at middle, each side of which is about equal in length to apical breadth of femur, three distinct setae on segment, the first situated ventrally on inner margin just beyond base of flange connection with femur proper, its length equal to length of flange, second seta twice as long as former, situated near margin just beyond distal extremity of flange connection, third seta prominent, located mid-dorsally between apex of femur and base of outer margin of flange; tibia about as broad as long, a strong seta situated ventrally near outer margin, a clavate, sensory seta located dorsally near outer margin, both of these setae on distal half of segment; tarsus twice as broad as long, with two short setae on inner margin and one short seta on outer margin; claw barely twice as long as width at base. *Genital papilla:* Length, 25μ; width, 23μ; subcordate, with anterior margin deeply emarginate, hind margin rounded truncate. *Anal plate:* Distinct, but radiating apodemes not clearly delimited. Central disc located two thirds length of genital papilla anterior to its anteromedial extremity, diameter of disc about equal to one half basal width of tarsus III. Two apodemes extending in anterolateral directions from disc, the other apodeme extending caudomedially, all about as long as tibia, III, terminating indistinctly. *Measurements:* Length from tip of rostrum to apex of genital papilla, 173μ; greatest width, 90μ; tip of rostral shield to main body suture, 67μ; width of body at main body suture, 79μ; length from main body suture to posterior body suture at mid-dorsum, 72μ.

Female: Body narrow, elongate, sides subparallel for most of their lengths; main body suture distinct, transecting body between coxae II and bases of coxae III; five distinct, dorsal, transverse sutures behind main body suture dividing hysterosoma into six segments. Anterior apodemes well-defined, those of legs I joining median apodeme opposite anterior bases of coxae I; leg II apodemes terminating between second pair of ventral setae and median apodeme, the latter indistinctly terminating just before main body suture. Posterior apodemes short, those of legs III converging anteriorly, terminating slightly behind third pair of ventral setae at point midway between lateral margins of body and mid-line, length of apodemes III about one third length of coxa III; apodemes IV converging anteriorly, terminating opposite mid-lengths of coxae III two thirds the distance from inner margin of coxa III to midline, the posterior extremities of apodemes IV at location of fourth pair of ventral setae. Posterior median apodeme absent. Genital cleft extending anteriorly from hind margin of penultimate segment more than half length of segment, the cleft furcate caudally, forming a nearly enclosed subcircular area about equal in diameter to width of tarsus III. Pseudostigmatic organs prominent, narrow pedicels shorter than length of expanded apices, the latter one and one-half times as long as greatest breadth appearing regular, egg-shaped; organs arising from heavily sclerotized, circular plates the diameters of which are slightly less than breadth of apical clubs, width of latter equal to width of tarsus II at base; basal plates of organs situated laterally, their posterior margins in line with front margins of coxae II. Tracheal openings with prominent sclerotized rings, located just behind anterolateral angles of cephalothoracic shield immediately beside first dorsal propodosomal setae, tracheae converging posteriorly and intersecting at middle of anterior median apodeme. *Dorsal chaetotaxy:* Two pairs of dorsal propodosomal setae; first pair prominent, nearly equal in length to length of capitulum, situated immediately beside tracheal openings; second pair prominent, length equal to length of leg II, situated immediately behind posterior margin of basal rings of pseudostigmatic organs. Six pairs of dorsal setae on hysterosoma; first pair with length equal to length of coxa III, situated on lateral margins of body midway between main body suture and anterior extremities of leg III apodemes; second pair of setae having length equal to one half length of coxae III, situated at caudal margin of first hysterosomal segment slightly anterior to and toward middorsum from basal condyles of coxae III; third pair, slightly longer than coxae IV, situated at caudal margin of third hysterosomal segment, in line with and above bases of coxae IV; fourth and fifth pairs of setae with lengths equal to length of apical segment of leg IV, the outer pair of setae situated on lateral margins of body at penultimate, transverse, hysterosomal suture, the other pair located at anterior third of penultimate segment the length of seta from middorsum; sixth pair of setae, one and one-half times as long as setae of fifth pair, situated on lateral margins of body close to anterior extremity of last hysterosomal segment. *Ventral chaetotaxy:* Two pairs of ventral propodosomal setae; first pair small, equal in length to width of tarsus I at base, located just medial to intersections of apodemes I with inner angles of coxae I; second pair of setae equal in length to width of tibia II at base, situated just posterior to hind extremities of apodemes II, the length of seta from median apodeme. Three pairs of ventral hysterosomal setae; first pair with length slightly greater than half the length of coxa III, located slightly anterior to forward extremities of apodemes III, the distance between setae being about equal to length of seta; second pair of setae slightly shorter than setae of first pair, situated in line with distal thirds of coxae III, one third the distance from inner margin of coxa to mid-body; third pair of setae equal in length to setae of second pair, situated at apex of body, the distance between them about twice the length of seta. *Capitulum:* Length, 25μ; width 25μ; broadest at base, tapering very slightly to bluntly rounded apex, hind margin shallowly emarginate; a pair of strong dorsal setae one and one-half times as long as basal width of tarsus I, located near lateral margins of capitulum slightly anterior to bases of palpi; palpi indistinctly two-segmented, apical segment with a minute, subterminal bristle, a ventral seta as long as basal width of tarsus I located near base of each palpus. *Legs:* Anterior pairs short, slightly longer than half the greatest width of body. Leg I with coxa subtrianglar, broader than long, without setae; femur one and one-half times as long as broad, with outer margin incurved at base, with four setae; genu nearly as broad at base as long, with four setae; tibiotarsus one and one-half times as long as broad, with two clavate, annulated sensory setae, one rodlike seta and twelve normal setae; tibiotarsus terminating in single claw projecting beyond broad, bilobed empodium. Leg II with coxa twice as broad as long, without setae; femur one and one-half times as long as broad, with three setae; genu broader than long, with two lateral setae, one stout, dorsal, lanceolate seta; tibia nearly as broad as long, with four normal setae; tarsus one and one-half times as long as broad, with two clavate, sensory setae and four normal setae; tarsus terminating in two strong claws beyond which projects a broad, subcircular empodium. Leg III with coxa narrow, elongate, four times as long as broad at apex, without setae; femur broader at apex than at base, three times as long as width of apex, with three setae; tibia tapering from base to apex, three times as long as broad at base, with four setae, three of which are on apical portion of segment; tarsus one half as long as tibia, four times as long as broad at base, expanded slightly at mid-segment, with four setae, all on apical half of segment; tarsus terminating in short pretarsus, one half as long as tarsus, bearing at its apex two strong claws beyond which projects a large, subcircular empodium. Leg

IV with coxa slightly longer than broad, inner margins slightly concave; trochanter ringlike, twice as broad as long; third segment narrow, elongate, slightly more than twice length of genu I, width at base equal to one half width of coxa III, two setae on segment, one short, ventrolaterally situated on outer margin, one half width of segment from its base, the other with length equal to length of femur III, located the width of segment from its apex; fourth segment narrow, elongate, length equal to length of tibia I, terminating in two long setae, one subapical, ventral, its length equal to distance from base of third segment to middle of fourth segment, terminal seta more than twice as long as subterminal seta. *Measurements:* Length from tip of capitulum to apex of opisthosoma, 228μ; tip of rostral shield to tip of opisthosoma, 208μ; front margin of rostral shield to main body suture, 71μ; width of body at main body suture, 86μ.

Holotype: Male, Pescadero, San Mateo Co., Calif., Oct. 28, 1949, R. E. Beer, salt-marsh grass.

Allotype: Female, Bolinas, Marin Co., California, Oct. 23, 1949, A. E. Pritchard, salt-marsh grass.

Paratypes: Four males, one female, same data as holotype, ten females, same data as allotype; one larva (morphotype), Marin Co., Calif., Nov. 13, 1949, salt-marsh grass, A. E. Pritchard.

Living specimens of both sexes of this mite are semitransparent with the body extremely flattened dorsoventrally. They were collected in the greatest numbers near the growing tips of salt-marsh grass beneath the sheaths of the grass blades, a habitat for which they are well adapted by their flattened bodies. Because of their nearly hyaline color, they are almost impossible to see without the aid of a low power microscope.

Steneotarsonemus spirifex (Marchal), new combination

(Plates 8, 17 and 22)

Tarsonemus spirifex Marchal, 1902, Bull. Soc. Ent., France, vol. 4, p. 99; Wahl and Müller, 1914, Rept. Augustenberg Agr. Exp. Inst., Stuttgart, p. 64; Lind et al, 1914, Beret. Statens Forsögsvirksamded i Plantekultur, Copenhagen, p. 3; Banks, 1915, U. S. Dept. Agr. Rept., 108, p. 104; Schoevers, 1915, Tijdschr. over Plantenziekten, Wageningen, p. 111; Oudemans, 1915, Tijdschr. over Plantenziekten, Wageningen, p. 124; Moznette, 1917, Jour. Agr. Res., vol. 10, no. 8, p. 373; Ewing, 1939, U. S. Dept. Agr. Tech. Bull., 653, p. 40.

Male: Body regular oval, tapering from main body suture to capitulum; broadest between main body suture and posterior extremities of coxae III, tapering from this point to apex of hysterosoma. Main body suture and posterior body suture distinct dorsally, the latter transecting body slightly behind coxae III. Anterior apodemes well-defined, those of legs I converging medially slightly behind posterior margins of coxae I; apodemes II converging medially, terminating before median apodeme in line with hind angles of coxae II; median apodeme terminating just before main body suture. Posterior apodemes distinct, those of legs III and IV joined anteriorly enclosing a bluntly rounded area; posterior median apodeme well-defined from point slightly behind anterior extremities of apodemes III and IV to hind margins of coxae IV. *Dorsal chaetotaxy:* Three pairs of strong setae on anterior half of propodosoma, spaced equidistant from each other and equidistant from lateral margins of body; anterior pair slightly longer than width of femur I, situated the length of seta behind anterior margin of rostral shield, separated from each other by distance equal to three fourths length of seta; second pair one half as long as first pair, the length of seta behind first pair and this distance from lateral margins of body; third pair twice as long as first pair, located behind second pair the same distance separating first and second pairs; fourth pair slightly longer than setae of first pair, located on posterior fourth of propodosoma two thirds length of seta from lateral body margins, this distance anterior to main body suture. Four pairs of dorsal setae on hysterosoma; first pair as long as combined lengths of tibia and tarsus II, located on lateral margins of body midway between main body suture and anterior condyles of coxae III; second pair of setae as long as width of genu III, situated the length of seta behind anterior condyles of coxae III, the length of seta from lateral margins of body; third pair of setae one and one-half times as long as genu III, situated in transverse line with setae of second pair, between body margin and genital papilla; fourth pair of setae as long as width of genu III, located near apex of hysterosoma beside genital papilla, separated from each other by a distance equal to four times length of seta. *Ventral chaetotaxy:* Four pairs of ventral setae; first pair minute, length about equal to half basal width of tarsus I, located the length of seta behind apodemes I the same distance laterad to anterior median apodeme; second pair of setae two and one-half times as long as first pair, located one and one-half times length of seta laterad to median apodeme, in line with hind condyles of coxae II; third pair of setae small, located near forward extremities of interapodemal areas delimited by connected apodemes III and IV; fourth pair of ventral setae small, located in same interapodemal area as third pair the length of seta from apodeme IV, in line with mid-lengths of coxae III. *Capitulum:* Length, 30μ; width, 33μ; subcordate, with posterior margin broadly truncate. Dorsal setae having length equal to two fifths greatest width of capitulum, situated near outer margins at apical two fifths of capsule, separated from each other by a distance equal to their combined lengths. Ventral setae one half as long as dorsal setae, located in line with latter, separated from each other by a distance equal to one and one-half times length of seta. Palpi short and broad, nearly as broad at base as long, indistinctly segmented, scarcely projecting beyond apex of capitulum, subterminal bristles conspicuous. Chelicerae long, needlelike, slightly longer than palpi, their tips projecting a short distance beyond apices of palpi. *Legs:* Anterior pairs subequal, shorter than distance from tip of rostral shield to main body suture. Leg I with coxa broader than long, subrectangular, without setae; femur one and one-half times as long as broad, outer margin incurved basally, inner margin straight, segment with three setae; genu as broad as long, with four setae; tibia slightly longer than broad, with three normal setae, one short, sensory peg, one long, clavate seta and one short, spinelike seta, these three specialized setae situated dorsolaterally in a transverse line near outer margin; tarsus surmounted by a large, broad empodium beyond which projects tip of single, stout, curved claw. Leg II with coxa broader than long, subrectangular, without setae; femur twice as long as broad, with outer margin convex basally, inner margin straight and half as long as outer margin, segment with three setae; tibia slightly longer than broad at base, tapering slightly toward apex, with four setae; tarsus slightly longer than broad at base, tapering to bluntly rounded apex, with one clavate seta two thirds as long as basal width of segment located middorsally on basal fourth of segment, one short, clavate seta one half as long as former located dorsally on outer margin at mid-segment and four normal setae; tarsus surmounted by a pair of large, spreading, curved claws beyond which projects a large, bilobed empodium. Leg III with combined length of four apical segments greater than combined length of four apical segments of leg I; coxa one and one-half times as long as broad at apex, without setae; femur more than twice as long as broad, lateral margins concave medially, segment with three setae; genu slightly longer than broad, sides diverging slightly toward apex, with two setae; tibia nearly twice as long as broad at base, tapering slightly toward apex, with four setae; tarsus one and one-half times as long as broad, tapering to rounded apex, with three setae; tarsus surmounted by two large, spreading, curved claws beyond which projects a broad, bilobed empodium. Leg IV robust; coxa with outer margin convex and twice as long as inner margin, segment slightly broader at apex than long, with one ventral seta on outer margin at mid-segment; femur twice as long as broad at base, outer margin convex for entire length of segment, inner margin with basal fourth convex apical third concave, a prominent, oval, lateral expansion at mid-segment, sclerotized portion of femoral expansion about as long as apical breadth of femur with its basal width about same dimension, one narrow, hyaline expansion projecting beyond sclerotized area and a broad hyaline expansion projecting beyond this, segment with three setae of about equal length, slightly longer than apical width of femur; tibia nearly twice as broad as long, with one large, clavate seta having length equal to width of segment, situated dorsally near outer margin at apical fourth of segment, one long tactile seta, three times as long as width of segment, situated ventrally near outer margin at mid-segment; tarsus one and one-half times as broad as long, with a single short bristle on outer, dorsolateral margin and two short bristles on inner margin; tarsus surmounted by a short, strong, curved claw. *Genital papilla:* Length, 34μ; width, 29μ; subcordate, with anterior margin deeply emarginate, crescent-shaped, narrow, sclerotized plate transecting papilla dorsally at caudal third, lateral extremities of plate narrowly pointed and directed caudolaterally, projecting beyond lateral margins of papilla, a pair of pointed, dorsally directed aedeagi projecting from plate between mid-papilla and lateral margins of papilla. *Anal plate:* Prominent; with central body diamond-shaped, as long as tibia IV, its pointed posterior extremity situated the width of tibia III anterior to forward margin of genital papilla, hornlike anterior diverging arms of apodemes curved and extending in anterolateral directions a distance equal to one and one-half times length of central body. *Measurements:* Length from tip of rostrum to apex of genital papilla, 200μ; width of body at point between anterior coxal condyles of legs III and main body suture, 130μ, tip of rostral shield to main body suture, 75μ.

Female: Body elongate oval, broadest at main body suture. Anterior apodemes distinct, those of legs I intersecting anterior extremity of median apodeme slightly behind inner coxal condyles of legs I; apodemes II extending from inner coxal condyles of legs II in caudomedial directions, terminating just before intersection with median apodeme, the latter continuing in a posterior direction decreasing in distinctness from point in line with hind margins of coxae II to its extremity midway between coxae II and main body suture. Posterior apodemes distinct, those of legs III extending in anteromedial directions from anterior condyles of coxae III for a distance equal to half length of coxa, the forward portions of apodemes with small, bulbous thickenings beyond which extend the recurved anterior extremities; apodemes IV thin and threadlike, extending from points the width of coxa III medial to posterior fourths of coxae III in anteromedial directions to points in line with anterior fourths of coxae III, the forward extremities of apodemes IV separated by a distance equal to length of tibia III; posterior median apodeme absent. Two short transverse apodemes, with lengths equal to half width of genu II, situated just anterior to main body suture, these apodemes with posterior extremities innermost, extending in diagonal direction to anterior extremities. Genital cleft extending as a slit from middle of penultimate segment to its hind margin where it terminates in a small, circular plate from each lateral margin of which a short, curved cleft projects forward. Pseudostigmatic organs conspicuous, ovoid apices longer than narrow pedicels, the latter attached basally to heavily sclerotized, ringlike plates nearly equal in diameter to width of apical expansions of organs; basal rings situated closer to anterior margins of coxae II than to posterior margins of coxae III. Tracheal openings distinct as sclerotized rings situated immediately behind anterolateral margins of rostral shield; tracheae extending posteriorly from openings to point of convergence at mid-body between anterior pairs of legs, at this point tracheae thicken into two bilobed, elongate structures each as long as apical width of femur. *Dorsal chaetotaxy:* Two pairs of dorsal setae on propodosoma; one pair as long as femur I, located dorsolaterally immediately behind stigmatal openings; second pair of setae about as long as legs I, situated near lateral margins of body slightly behind and medial to basal rings of pseudostigmatic organs. Six pairs of dorsal hysterosomal setae; two pairs of setae in line transversally, outer pair as long as tibia II, situated the length of seta from lateral margins of body, half length of seta behind main body suture, inner pair as long as genu II, located the length of seta behind main body suture; third pair of setae with length equal to width of femur III, located slightly behind and laterad to coxae IV; fourth and fifth pairs of setae subequal in length, as long as width of tibia IV, outer pair located on lateral margins of body the length of seta in front of penultimate hysterosomal suture, inner pair located in line with outer pair, separated from each other by distance equal to twice length of seta; sixth pair of setae slightly longer than apical segment of leg IV, located on lateral margins of apical histerosomal segment. *Ventral chaetotaxy:* Two pairs of ventral propodosomal setae; one pair with length equal to width of tarsus I, located slightly in front of mid-lengths of apodemes I; second pair of setae slightly longer than first pair, located between inner condyles of coxae II and anterior median apodeme, two thirds length of seta behind apodemes II. Two pairs of ventral hysterosomal setae; two long setae as long as coxa III, located the basal width of tarsus I in front of anterior extremities of apodemes III; second pair of setae as long as length of apical segment of leg IV, located on apodemes IV, a distance one fourth length of apodemes from posterior extremities. *Capitulum:* Length, 32μ; width, 30μ; subcordate, caudal margin deeply emarginate, anterior margin bluntly rounded. Setae of capitulum normal, palpi indistinctly segmented. *Legs:* Anterior pairs short and stout, length subequal, about as long as half width of body at main body suture. Leg I with coxa subquadrangular, slightly longer than broad, without setae; femur one and one-half times as long as broad, with three setae; genu nearly one and one-half times as long as broad, with four setae; tibiotarsus about twice as long as broad at base, with three specialized, sensory setae and ten normal setae; tibiotarsus surmounted by a long, broad empodium beyond which projects tip of strong, curved claw. Leg II with coxa subquadrangular, slightly broader than long, without setae; femur about one and one-half times as long as broad, outer margin incurved basally, segment with three setae; genu as broad as long, with three setae; tibia one and one-half times as long as broad, with four setae; tarsus slightly longer than broad at base, tapering from base to narrowly rounded apex, with two short, clavate setae, the length of one equal to half the basal width of segment, situated dorsally near inner margin the length of seta from base of segment, the shorter seta one half as long as former, located near outer margin opposite other clavate seta, three normal setae; tarsus terminated by pair of spreading, curved claws between and beyond which projects a broad, bilobed empodium. Leg III with coxa narrow, elongate, four times as long as greatest breadth, without vestiture; femur two thirds as long as coxa, apical width equal to one third length of segment, lateral margins divergent from basal third to apex, segment with three setae; tibia slightly shorter than femur, tapered from base toward apex, width at base one third length, with four setae; tarsus narrow, elongate, sides subparallel for most of their lengths, apex bluntly rounded, with three setae; tarsus surmounted by a pair of large, curved, spreading claws between and beyond which projects a broad, bilobed empodium. Leg IV with coxa subquadrangular, slightly broader at apex than at base, slightly longer than greatest breadth, length equal to width of coxa III; trochanter subtriangular, broader than long; third segment slender, elongate, tapered slightly from base to apex, as long as combined lengths of femur and genu I, segment with one basal seta one third length of segment, located on outer ventral margin the width of segment from base, one ventral seta nearly half as long as segment located mid-ventrally twice breadth of segment from apex; fourth segment narrow, elongate, slightly expanded at apex, length slightly greater than breadth of tibia III at base, with two elongate setae on segment, one situated ventrally at apical fourth of segment, its length three times length of segment, the other seta on dorsal surface at apex of segment, its length more than twice combined lengths of two apical segments of leg IV. *Measurements:* Length from tip of capitulum to apex of opisthosoma, 314μ; tip of rostral shield to tip of opisthosoma, 288μ; front margin of rostral shield to main body suture, 81μ; width at main body suture, 131μ.

Types: Vienna, Austria, on *Avena sativa.*

Location of types: Unknown.

Material consulted and studied by the present author included specimens identified with the following data: Ithaca, N. Y., Apr. 16, 1929, W. E. Blauvelt, corn; Douglas, Ariz., Aug. 25, 1932, W. W. Jones, on *Panicum obtusum;* Biophysical greenhouse, Inspection H., Wash. D. C., from teosinte plants, F.H.B. 83699; Manhattan, Kansas, Sept. 16, 1946, D. A. Wilbur, buffalo grass; Riverside, Calif., Aug. 1, 1947, E. W. Baker, Bermuda grass.

This species is rather well known, easily recognized and generally distributed.

Steneotarsonemus pallidus (Banks), new combination

(Plates 4, 17 and 22)

Tarsonemus pallidus Banks, 1901, Proc. Ent. Soc. Washington, vol. 4, p. 294; Banks, 1907, Proc. U. S. Natl. Mus., vol. 32, no. 1553, p. 615; Banks, 1915, U. S. Dept. Agr. Rept., 108, p. 104; Weiss, 1915, Ent. News, vol. 26, no. 4, p. 149; Ewing, 1917, Jour. Econ. Ent., vol. 10, no. 5, p. 497; Ewing, 1939, U. S. Dept. Agr. Tech. Bull., 653, p. 41; Garman, 1917, Maryland Agr. Exp. Sta. Bull., 208, p. 327; Moznette, 1917, Jour. Agr. Res., vol. 10, no. 8, p. 373; Rose, 1917, Agr. Gazette, Canada, vol. 4, p. 174; Dustan, 1929, Ann. Rept. Quebec Soc. Protection Plants (1928-29), p. 48; Doucette and Baker, 1932, Jour. Econ. Ent., vol. 25, no. 2, p. 417; Ewing and Smith, 1935, Proc. Ent. Soc. Washington, vol. 36, p. 267; Smith, 1935, Jour. Econ. Ent., vol. 28, no. 1, p. 91; Smith and Goldsmith, 1936, Hilgardia, vol. 10, no. 3, p. 53;

Massee, 1937, Pests of fruit and hops, London, p. 229; Massee, 1944, Rept. East Malling Res. Sta. (1943), p. 58; Essig and Hoskins, 1944, California Agr. Extension Cir., 87, p. 118.

Tarsonemus fragariae Zimmerman, 1905, Zeitschr. Mäharischen Landesmuseums, vol. 5, no. 1, p. 91; Schoyen, 1914, Christiana, p. 31; Ferdinandsen and Rostrup, 1919, Tidskr. Planteavl., vol. 26, p. 683; Gram and Rostrup, 1924, Tidskr. Planteavl., vol. 30, p. 361; Naumann, 1924, Kranke Pflanze, Dresden, vol. 1, no. 7, p. 134; Massee, 1930, Gard. Chron., vol. 87, no. 2250, p. 110; Massee, 1930, Jour. Pomol. and Hort. Sci., vol. 8, no. 4, p. 305; Massee, 1931, Ann. Rept. East Malling Res. Sta., vol. 2 (Supplement 1928-30), p. 189; Massee, 1933, Ann. Rept. East Malling Res. Sta. (1933), p. 117; Ewing and Smith, 1935, Proc. Ent. Soc. Washington, vol. 36, p. 267.

Male: Body broad oval, broadest just anterior to forward extremities of coxae III. Apodemes conspicuous and well-defined, those of legs I as long as tibia I, extending in posteromedial directions from innermost angles of coxae I, converging medially in line with anterior extremities of coxae II. Apodemes II about twice as long as apodemes I, subparallel to the latter, curving abruptly caudad just before intersection with median apodeme, terminating indistinctly just beyond this point. Anterior median apodeme extending indistinctly from main body suture to point opposite posteromedial termina of apodemes II, well defined from this point to its anterior extremity at V-shaped juncture of apodemes I. Apodemes III clearly defined for their entire lengths, extending from anterior extremities of coxae III in anteromedial direction, curving at right angles at points the length of femur I behind main body suture, intersecting apodemes IV near forward extremities of the latter. Apodemes IV extending from outer basal angles of coxae IV in anteromedial directions, converging with apodemes III and median apodeme anteriorly, curving outward just behind anterior extremities of apodemes III, intersecting median apodeme just behind these points. Posterior median apodeme bifurcate caudally, the arms extending anteriorly from inner basal angles of coxae IV, converging at point in line with posterior thirds of coxae III, the apodeme extending forward to intersection with apodemes IV at point a distance equal to combined lengths of femur, genu and tibia III in front of anterior extremity of genital papilla. Anterior margin of propodosoma not extended to form a cephalothoracic shield, its forward extremity broadly truncate, slightly concave. *Dorsal chaetotaxy:* Propodosoma with four pairs of dorsal setae in linear arrangement, the setae equidistant from lateral margins of propodosoma; first pair of setae with length equal to greatest width of capitulum, located the length of seta from anterior margin of propodosoma, four fifths length of seta from lateral margins of propodosoma; setae of second pair three fifths as long as setae of first pair, situated two thirds length of seta behind and slightly laterad from setae of first pair; third pair of setae about two and one-half times as long as setae of first pair, located a distance three fifths length of second seta behind and slightly laterad from latter; fourth pair of setae slightly shorter than second pair, situated two thirds length of seta behind and slightly laterad from setae of third pair. Hysterosoma with four pairs of dorsal setae; first pair as long as first pair of propodosomal setae, situated near lateral margins of body midway between anterior extremities of coxae III and main body suture; second pair of setae two thirds as long as first pair, slightly stouter than latter, located near lateral margins of body in line with anterior thirds of coxae III; third pair of dorsal hysterosomal setae subequal in length to setae of second pair, located the length of seta from caudolateral margins of body in line with bases of coxae IV; fourth pair of setae slightly longer than third pair, situated near caudolateral margins of body beside basal third of genital papilla, setae separated from each other by a distance equal to two and one-half times length of seta. *Ventral chaetotaxy:* Propodosoma with two pairs of ventral setae; first pair minute, length equal to one-half basal width of tarsus I, located near centers of interapodemal areas defined by apodemes I, II and median apodeme; second pair of setae one half as long as tibia I, located slightly mesad from centers of interapodemal areas defined by apodemes II, median apodeme and main body suture. Hysterosoma with two pairs of setae, one seta of each pair located in each interapodemal area delimited by apodemes III and IV; setae of first pair with length equal to two thirds basal width of tarsus I, located one half length of seta from apodemes III in a line with anterior extremity of median apodeme; setae of second pair one and one-half times as long as former setae, situated one half length of seta from apodeme IV, two fifths length of apodeme from its posterior extremity. *Capitulum:* Subcordate, posterior margin truncate; length including projecting palpi, 38μ; greatest width, 31μ. Dorsal setae with length equal to one half greatest width of capitulum, located near lateral margins at apical two fifths. Ventral setae one half as long as dorsal setae, situated near bases of palpi, separated from each other by a distance equal to length of seta. Palpi stout, of moderate length, slightly longer than tibia I, indistinctly segmented, truncate at apex. Chelicerae short, needlelike, extending forward to tips of palpi; cheliceral sheaths conspicuous, without striae. *Legs:* Anterior pairs robust, legs I slightly longer than legs II. Leg I with coxa subquadrangular, one and one-half times as broad as long, without vestiture; femur having length equal to width of coxa or two thirds greatest width of capitulum, slightly longer than broad, inner margin one-half as long as outer margin, sides converging slightly toward apex, segment with three setae; genu two thirds as long as femur, about as broad as long, with four setae; tibia slightly longer than genu, one and one-fourth times as long as broad, with one spinelike seta having length equal to one third basal width of segment located near outer margin at basal third, one narrow, clavate seta with length equal to one half basal width of segment located dorsally beside spinelike seta slightly closer to mid-segment, one clavate seta with length equal to one fourth basal width of segment located just mesad from previous seta, this position being about middorsal on segment, five normal setae; tarsus slightly longer than tibia, twice as long as broad at base, tapering to broadly rounded apex, with one short and one long clavate setae, eight normal setae; tarsus surmounted by a short, narrow pretarsus, its length equal to one half basal width of tarsus, bearing at its apex a large, subcircular empodium and a large curved claw the tip of which projects beyond apex of empodium. Leg II with coxa subtriangular, as broad as long, without setae; femur as long as femur I, outer margin twice as long as inner margin, width of segment equal to length, with three setae; genu one half as long as femur, one and one-third times as broad as long, margins converging slightly toward apex, with four setae; tibia slightly longer than genu, as long as broad, with four setae; tarsus as long as tibia, one and one-half times as long as broad at base, tapering to narrowly rounded apex, with one ovate, annulated seta having length equal to one half basal width of segment, located dorsally near inner margin at basal third, four normal setae; tarsus surmounted by a short pretarsus, its length equal to one third basal width of tarsus, bearing at its apex two large, curved, spreading claws between and beyond which spreads a large, broad, bilobed empodium. Leg III with coxa subtriangular, length equal to combined lengths of femur and genu I, one half as broad as long, outer margin convex, inner margin straight, segment without vestiture; femur three fourths as long as coxa, about one half as broad as long, outer margin three fourths as long as inner margin, segment with one seta; genu about one half as long as femur, as broad as long, lateral margins subparallel, with three setae; tibia one and one-third times as long as genu, one and one-half times as long as broad at base, expanding slightly toward apex, with four setae; tarsus as long as tibia, twice as long as broad at base, tapering to narrowly rounded apex, with three setae; tarsus terminated by a short, narrow, pretarsal segment, bearing at its apex two stout, curved, spreading claws between and beyond which projects a large, broad empodium, the width of latter equal to width of tarsus at base. Leg IV with coxa subquadrangular, one and one-third times as broad as long, width at base equal to combined lengths of genu and tibia III, with one ventral seta; femur as long as combined lengths of three apical segments of leg III, width at base slightly more than one half length of segment, width at apex one half width at base, outer margin slightly convex, inner margin with a large, smoothly convex expansion beginning at about mid-segment and terminating distally just before apex, width of segment at apical third measured at broadest point of femoral flange equal to two thirds length of segment, three setae on segment; tibia with length equal to one third length of outer margin of femur, with one dorsal, rodlike seta one half as long as segment located near outer margin at apical fourth, one ventral seta longer than leg IV situated near outer margin at apex; tarsus one third as long as tibia, broader than long, with three setae; tarsus surmounted by a large, curved claw, its length equal to three fourths length of tibia, about three times as long as broad at base, apex bluntly rounded. *Genital papilla:* Short and broad, subcordate, with anterior margin emarginate, posterior margin rounded truncate; length, 35μ; width, 40μ. *Measurements:* Length from tips of palpi to apex of genital papilla, 205μ; main body suture to apex of genital papilla, 108μ; anterior margin of propodosoma to main body suture, 61μ; width of body at point midway between anterior extremities of coxae III and main body suture, 112μ.

Female: Body elongate oval, broadest at mid-length. Anterior apodemes distinct and clearly defined; apodemes I as long as tibia II, extending in posteromedial directions from innermost angles of coxae I, converging medially in line with posterolateral angles of coxae I; apodemes II subparallel to apodemes I for most of their lengths, extending from inner angles of coxae II to median apodeme, intersecting the latter indistinctly at point the basal width of tarsus II anterior to main body suture. Anterior median apodeme extending from V-shaped juncture of apodemes I to main body suture, its appearance indistinct for a short distance at about mid-length and again from point of juncture of apodemes II to main body suture. Posterior apodemes conspicuous; those of legs III extending in anteromedial directions from anterior extremities of coxae III, each apodeme about one half as long as coxa III, their forward extremities located a distance equal to the length of tibiotarsus I behind main body suture and separated from each other by a distance equal to combined lengths of three apical segments of leg II; apodemes IV slightly longer than apodemes III, extending in anteromedial directions from points one third width of coxa III from inner margins of coxae III at their posterior thirds to points in line with anterior fourths of coxae III, the forward extremities of apodemes being separated from each other by a distance equal to basal width of tarsus II; posterior median apodeme evident only as a short, median, longitudinal line, as long as genu II, extending caudad from point in line with anterior extremities of apodemes III. Hysterosoma with five conspicuous transverse sutures, two transecting body before posterior extremities of coxae III, the other three transecting body in opisthosomal region. Dorsum of propodosoma not projected anteriorly to form a cephalothoracic shield, its anterior margin situated immediately behind capitulum. Pseudostigmatic organs as long as tibiotarsus I, expanded apex subcircular, with diameter equal to three fourths basal width of tibiotarsus I; pedicel short, length equal to one half diameter of expanded apex; basal areolus subcircular, its diameter about equal to one half diameter of expanded apex of organ. Stigmatal openings distinct as sclerotized rings on small elevated dorsal tubercles, situated in line with Y-shaped juncture of apodemes I and median apodeme, separated from each other by a distance equal to combined lengths of femur and genu II; tracheae not clearly defined. *Dorsal chaetotaxy:* Propodosoma with two pairs of dorsal setae; first pair as long as genu I, situated one sixth length of seta anteromesad from stigmatal openings; setae of second pair with length about equal to three fourths width of body at main body suture, located the length of tibia II behind and slightly medial to basal areoli of pseudostigmatic organs. Hysterosoma with six pairs of dorsal setae; first pair three fourths as long as genu II, located one and one-half times length of seta from lateral margins of body, this distance behind main body suture; setae of second pair subequal in length to setae of first pair, located in line with latter, slightly laterad from medial extremities of apodemes III; third pair of setae as long as second pair, located in line with coxae IV, separated from each other by distance equal to distance between bases of femora III; fourth pair of setae slightly longer than setae of second pair, located two thirds length of seta from lateral margins of body, about five times length of seta behind posterior extremities of coxae III; fifth pair of setae as long as genu II, located two and one-half times length of seta behind and medial to setae of third pair, separated from each other by this distance; sixth pair of setae slightly longer than fourth pair, located one half length of seta from lateral margins of body twice length of seta from apex. *Ventral chaetotaxy:* Propodosoma with two pairs of ventral setae; first pair minute, length equal to one half basal width of tibiotarsus I, located one and one-half times length of seta from median apodeme at points this distance behind anterior extremity of latter; setae of second pair three times as long as setae of first pair, located slightly behind apodemes II at points the length of seta from inner angles of coxae II. Hysterosoma with three pairs of ventral setae; first pair as long as first pair of dorsal hysterosomal setae, situated the length of seta mesad from anteromedial extremities of apodemes III; setae of second pair one and one-half times as long as setae of first pair, located just anterior to caudal extremities of apodemes IV; third pair of setae minute, as long as first pair of ventral propodosomal setae, situated the length of seta from apex of hysterosoma, separated from each other by a distance equal to three times length of seta. *Capitulum:* Length including palpi, 43μ; greatest width, 35μ; subcordate, with caudal margin rounded truncate, anterior margin truncate. Dorsal setae with length equal to length of tibia II, located near lateral margins, slightly distad from mid-length of capitulum, separated from each other by a distance slightly greater than their combined lengths. Ventral setae as long as but more slender than dorsal setae, located in line with dorsal setae, separated from each other by a distance equal to two thirds length of seta. Palpi short and broad, indistinctly segmented, length equal to length of genu II, width of truncate apex nearly equal to one half length of appendage, with prominent terminal seta near outer margin. Chelicerae needlelike, projecting between and slightly beyond tips of palpi. *Legs:* Anterior pairs short, robust. Leg I with coxa subquadrangular, length equal to two thirds width, three fourths as wide as capitulum, without vestiture; femur length equal to three fourths width of coxa, nearly as broad as long, with one stout, lanceolate seta with length equal to two fifths apical width of segment located dorsally near outer margin at apical fourth of segment and three normal setae; genu nearly as long as femur, one and one-third times as long as broad at base, tapering slightly toward apex, with four setae; tibiotarsus one and two-thirds times as long as genu, twice as long as broad at base, tapering slightly from base to broadly rounded apex, with three specialized sensory setae and twelve normal setae; tibiotarsus surmounted by a broad, subcircular empodium, its diameter equal to two thirds basal width of tarsus, with tip of long, curved claw projecting beyond its apex. Leg II with coxa subequal in size to coxa I, without setae; femur as long as femur I, with three setae; genu two thirds as long as femur, slightly broader at base than long, tapering slightly toward apex, with one broad, spinelike seta three fourths as long as segment located one half length of seta from outer margin at basal sixth of segment, two normal setae; tibia as long as genu, as broad as long, with four setae; tarsus as long as tibia, one and one-third times as long as broad at base, tapering slightly to broadly rounded apex, with one lanceolate, annulated seta having length equal to one half basal width of segment located near outer margin at basal fifth, one long, tactile seta and three normal setae; tarsus terminated by a short, broad pretarsus, its length equal to one half basal width of tarsus, two thirds as broad as long, bearing at its apex two large, curved, spreading claws between and beyond which projects a large, broad, subcircular empodium. Leg III with coxa narrow, elongate, length equal to combined lengths of genu and tibiotarsus I, two fifths as broad as long, without vestiture; femur as long as tibiotarsus I, basal third bulbous, segment with four setae; tibia nearly as long as femur, one half as broad as long, lateral margins converging slightly from mid-segment toward apex, with four setae; tarsus broad, elongate, two thirds as long as tibia, about two and one-half times as long as broad at base, with four setae; tarsus surmounted by short, broad pretarsus, as long as basal width of tarsus, bearing at its apex two large, curved, spreading claws between and beyond which projects a large, broad empodium. Leg IV with coxa small, subquadrangular, as broad as long, without setae; trochanter small, collarlike, twice as broad as long, without vestiture; third segment slender, elongate, as long as combined lengths of tibia and tarsus III, about eight times as long as broad at base, lateral margins subparallel, one ventral seta with length equal to basal width of segment located near outer margin the length of seta from base, one stout, ventral seta one fourth as long as segment situated near outer margin one half length of seta from apex; fourth segment one half as long as third segment, about six times as long as broad at base, lateral margins subparallel for most of their lengths, with one stout seta as long as segment situated near outer margin at apical fourth, one terminal seta more than one and one-half times as long as leg IV. *Measurements:* Tips of palpi to apex of hysterosoma, 292µ; main body suture to apex of hysterosoma, 188µ; width of body at anterior extremities of coxae III, 149µ.

Types: Jamaica, New York, F. A. Sirrine, on leaves of chrysanthemum in greenhouse.

Location of types: U. S. National Museum, slide no. 1132. One male specimen in this cotype series has been encircled by the present writer and is hereby designated lectotype.

Material studied by the present author in addition to the cotype series included specimens accompanied by the following data: Geneva-Sunnydale Nursery, San Francisco, Calif., Sept. 24, 1948, R. E. Beer, cyclamen under glass; Geneva-Sunnydale Nursery, San Francisco, Calif., June 16, 1949, R. E. Beer, ivy under glass; Calif. Evergreen Nursery, San Francisco, Calif., July 7, 1949, R. E. Beer, ivy under glass; Salinas, Calif., Aug. 17, 1949, C. E. Scott, field grown strawberries (var. Lassen); East Malling, Kent, England, June 27, 1949, A. M. Massee and J. R. Gors, strawberry.

After completing studies of European material and evaluating descriptions made by previous authors, this author is convinced that the recognition of *T. fragariae* Zimmerman as a synonym of S. *pallidus* (Banks) is well founded. Most contemporary authors are agreed in this point at the present time although some European workers still interject the name *T. fragariae* into the literature of the present from time to time.

Some limited biological studies of this species by the present author appear to indicate that one reason for expecting the involvement of two distinct species might well be due to the narrow range of environmental tolerances of S. *pallidus.* Although the species frequently causes severe damage to field grown strawberries in the San Francisco Bay area of California, it seldom is found on other outdoor plants which are normally favored as hosts when grown under greenhouse conditions. Another fact worthy of note, and one which has been mentioned by other authors, is that transferral of specimens from one host to another under laboratory conditions seldom meets with success as far as establishing new infestations on the new host is concerned. In spite of the fact that much work has been done on biological studies of this well known economic species, it appears to this author that much has yet to be learned about the ecological requirements of S. *pallidus.*

This species appears to have a definite affinity with other members of the genus, being closer in morphological resemblance to S. *ananas* than to other species in the group. The omnivorous food habit and the unspecialized general body shape as well as other less obvious characters lead this author to believe that S. *pallidus* is perhaps the most primitive species in the genus.

Steneotarsonemus ananas (Tryon), new combination

(Plates 6, 17, and 22)

Tarsonemus ananas Tryon, 1898, Queensland Jour. Agr., vol. 3, no. 6, p. 458; Rutherford, 1913, Trop. Agr. Peradeniya, vol. 41, no. 6, p. 490; Moznette, 1917, Jour. Agr. Res., vol. 10, no. 8, p. 373; Ewing, 1939, U. S. Dept. Agr. Tech. Bull., 653, p. 34; Bianchi, 1940, Proc. Hawiian Ent. Soc., vol. 10, no. 3, p. 375.

Male: Body elongate, oval, broadest slightly behind main body suture midway between coxae II and III, tapering from coxae III to bluntly rounded apex. Main body suture and posterior body suture distinct. Apodemes of legs I joining median apodeme in line with posterior angles of coxae I, median apodeme extending caudad from point of juncture of apodemes I nearly to main body suture. Apodemes II converging on median apodeme, their median extremities curving abruptly caudad just before joining median apodeme. Apodemes III, IV and posterior median apodemes distinct for their entire lengths, their anterior extremities connected at points about one third distance from main body suture to anterior angles of coxae III, defining four clearly delimited, elongate, connected, interapodemal areas with anterior margin of total area scalloped. *Dorsal chaetotaxy:* Four pairs of setae on propodosoma in linear arrangement; first pair shortest, fourth pair twice as long as first pair and slightly longer than second pair, third pair stout and much longer than others. Four pairs of dorsal setae on hysterosoma. *Ventral chaetotaxy:* Propodosoma with two pairs of ventral setae; first pair minute, length equal to two thirds basal width of tarsus I, located slightly posterior to juncture of apodemes I, twice length of seta from median apodeme; second pair of setae subequal in size to first pair, situated in centers of areas delimited by apodemes II and main body suture. Hysterosoma with two pairs of ventral setae; first pair twice as long as second pair of ventral propodosomal setae, located in apodemal areas of legs III, one half length of seta behind anterior extremities of areas; second pair of ventral hysterosomal setae as long as first pair, situated on apodemes IV at points one third distance from posterior extremities. *Capitulum:* Length, 35μ; width, 39μ; subcordate, hind margin with a slight medial cleft. Pair of setae situated dorsolaterally on anterior fourth of capitulum, their lengths equal to one third width of capitulum. Ventral setae two thirds as long as dorsolateral setae, situated near inner basal angles of segments. Palpi indistinctly segmented, projecting beyond apex of capitulum. Chelicerae projecting conelike, between palpi, terminating anteriorly in line with tips of palpi. *Legs:* Anterior pairs subequal in size. Leg I with coxa subtriangular, broader than long, without setae; femur with outer margin one and one-half times as long as breadth of segment, basal half incurved, inner margin as long as breadth of segment, with two dorsal and two ventral setae, all situated near mid-segment; genu as broad as long, slightly tapered toward apex, with four setae; tibia slightly longer than broad, with five normal setae and one long, clavate, sensory seta; tarsus twice as long as broad at base, tapering to bluntly rounded apex, with five normal setae and one stout, clavate seta; tarsus terminated by a broad empodium beyond which projects a single curved claw. Leg II with coxa broader than long; shape and chaetotaxy of femur and genu similar to these segments of leg I; tibia slightly longer than broad, with four setae; tarsus three times as long as basal width, tapering toward apex, with three normal setae and two clavate setae, one as long as basal width of segment the other one half as long; tarsus terminated in a broad, bilobed empodium, projecting beyond large, spreading, curved claws. Leg III with coxa subtriangular, basal breadth one and one-half times length of slightly curved outer margin of segment; femur twice as long as broad, partially divided at about mid-segment by an incomplete suture, segment with two setae; genu nearly as broad as long, sides subparallel, with three setae; tibia one and one-half times as long as broad, sides slightly curved, with four setae; tarsus terminating in a broad, bilobed empodium which projects slightly beyond large, spreading, curved claws. Leg IV with coxa slightly broader than long, lateral margins curved, with one seta; femur two and one-half times as long as broad at base, broadly truncate apex two thirds as broad as basal width of segment; outer margin of segment slightly and uniformly curved, inner margin with broadly rounded flange which joins segment in a smooth curve anteriorly and at an acute angle posteriorly, width of segment at flange equal to three fourths length of segment, conspicuous setae on segment; tibia nearly one and one-half times as long as broad, outer margin convex bent at angle at apical third of segment, inner margin abruptly concave at mid-segment, with two setae, one as long as basal width of segment, broad at base pointed at apex, situated dorsally near outer lateral angle slightly behind tip of segment, the other seta nearly as long as femur IV, very broad at base, situated mid-ventrally on apical third of segment; tarsus small, broader than long, inner margin strongly convex, segment bearing three small setae; tarsus terminates in prominent, broad, curved claw, bluntly rounded at apex. *Genital papilla:* Length including projecting appendages, 30μ; greatest width, 32μ; subcordate, with anterior margin deeply emarginate, posterior margin bluntly rounded. Apex of body projects slightly beyond papilla. *Measurements:* Length from tips of palpi to apex of genital papilla, 213μ; apex of cephalothoracic shield to tip of genital papilla, 183μ; tip of shield to main body suture, 68μ; width of body at main body suture, 90μ; width of body midway between main body suture and anterior extremities of coxae III, 105μ; length from main body suture to posterior body suture, 90μ.

Female: Body elongate, oval; main body suture distinct, ventrolateral extremities curved forward; hysterosoma transected by five indistinct sutures, two of which are behind legs IV. Anterior apodemes well defined, those of legs I joining median apodeme opposite inner condyles of coxae I, median apodeme extending posteriorly to point opposite inner condyles of coxae II; apodemes of legs II with anterior extremities at inner coxal condyles of legs II, converging in posteromedial direction, terminating just before juncture at points slightly behind and toward lateral margins from posterior extremity of median apodeme. Posterior apodemes well defined, those of legs III extending from anterolateral extremities of legs III to points slightly laterad from first ventral hysterosomal setae. Leg IV apodemes extending in anterior converging direction from points slightly medial to hind extremities of coxae III to points in line with anterior fourths of coxae III, their forward extremities separated by a distance equal to one half distance between inner angles of coxae IV. Posterior median apodeme absent. Genital cleft located in a distinct ventral plate occupying penultimate segment; sides of plate diverging caudally, anterior margin two thirds as broad as emarginate posterior margin which is as broad as length of penultimate segment of leg IV. Pseudostigmatic organs conspicuous, with short, narrow pedicels supporting broad ovoid termina, pedicels inserted basally on subcircular, sclerotized plates with diameters slightly less than width of expanded apices of organs, located between and dorsad from coxae I and II. Stigmatal openings defined by sclerotized rings situated dorsolaterally in line with anterior angles of coxae I, the width of tarsus I behind anterolateral angles of rostral shield. Tracheae indistinct. *Dorsal chaetotaxy:* Two pairs of dorsal setae on propodosoma; first pair as long as genu II, located on anterolateral angles of rostral shield, slightly laterad from inner angles of coxae II. Hysterosoma with six pairs of dorsal setae. *Ventral chaetotaxy:* Two pairs of ventral propodosomal setae; first pair with length equal to apical width of tibiotarsus I, located between inner margins of coxae I and juncture of apodemes I; second pair with length subequal to first pair, situated near mid-lengths of apodemes II. Hysterosoma with two pairs of ventral setae; first pair of setae as long as basal width of tibiotarsus I, located half length of seta medial to anterior extremities of apodemes III; second pair of setae subequal in length to first pair, located at hind extremities of apodemes IV. *Capitulum:* Length including projecting palpi, 34μ; greatest width, 39μ; broadest at base, tapering slightly to truncate apex, hind margin emarginate. Dorsal setae one half as long as tibiotarsus I, located on lateral margins at anterior fourth of capitulum. Ventral setae as long as width of tibiotarsus I, located the length of seta behind apex of capitulum, separated from each other by a distance equal to length of seta. Palpi indistinctly segmented, with two subapical bristles. Chelicerae converging to conical anterior, projecting forward between palpi and terminating in line with the latter. *Legs:* Anterior pairs short and broad. Leg I with coxa subtriangular, as broad as long, without setae; femur slightly longer than greatest breadth, outer margin curved inward at base, with two dorsal and two ventral setae near mid-segment; genu one and one-half times as long as broad at base, tapering slightly toward apex, with four setae; tibiotarsus two and one-half times as long as broad at base, tapering slightly to truncate apex, with nine normal setae and four clavate, sensory setae; tibiotarsus terminated by a single curved claw projecting beyond broad empodium. Leg II with coxa one and one-half times as broad as long, without setae; femur longer than broad, with two dorsal and one ventral setae; genu as long as broad at base, tapering slightly toward apex, with two normal setae and one broad, lanceolate spine, the latter nearly as long as segment and situated dorsally near base of segment; tibia as broad as long, sides subparallel, with two dorsal and two ventral setae; tarsus one and one-half times as long as broad at base, tapering to rounded apex, with four normal setae and two sensory pegs, the latter located dorsally near base of segment, the one at mid-segment clavate and two thirds as long as basal width of segment, the other close to outer margin of segment, equal in length to clavate seta, broad at base and tapered abruptly to pointed apex; tarsus terminated by two prominent, curved, spreading claws with broad empodium projecting beyond their apices. Leg III with coxa as long as tibiotarsus I, inner margin straight, outer margin strongly convex, segment without setae; femur nearly four times as long as broad at apex, tapering from apex to basal third, with three setae; tibia nearly three times as long as broad, sides subparallel, with four setae; tarsus slender, elongate, three times as long as broad at base, tapering to narrowly rounded apex, with four setae; tarsus terminating in two strong, curved, spreading claws beyond which projects a broad, medial, single-lobed empodium. Leg IV with coxa subtriangular, broader than long, without setae; trochanter small, collarlike, broader than long, outer margins convex, without setae; third segment narrow, elongate, rodlike, nearly as long as combined lengths of tibia and tarsus III, as broad at base as basal width of tarsus III, with one seta on outer margin having length equal to basal width of segment and located one third length of seta from base of segment, another seta one third as long as segment situated mid-ventrally one third length of seta from apex of segment; fourth segment one third as long as third segment, sides subparallel, apex bluntly rounded, with one ventral seta slightly more than twice as long as segment situated one third length of segment before apex, one long, terminal seta with length more than twice combined lengths of two apical segments of leg. *Measurements:* Length from tips of palpi to apex of hysterosoma, 235μ; tip of rostral shield to tip of hysterosoma, 210μ; front margin of rostral shield to main body suture, 61μ; width of body at main body suture, 101μ.

Types: South Queensland, Australia, on *Ananas comosus.*

Location of types: Unknown.

Material studied by this writer include specimens from a single collection with the following data: Wahiawa Valley, Oahu, Hawaii, Nov. 1949, Walter Carter, pineapple.

Ewing (1939) did not have male specimens on hand for study at the time of his revision of the group, and, as a result, his acceptance of Tryon's original description of this sex led him to place the species as a possible connecting link between the genus *Tarsonemus* and his new genus *Hemitarsonemus.* This placement of S. *ananas* was made on the basis of the presence of a femoral spur on the inner margin of femur IV of the male, which as this author has pointed out was an erroneous observation of the femoral flange. In general morphological characters S. *ananas* appears to fall between S. *spirifex* and S. *pallidus.*

The species is apparently quite destructive to pineapple, the only recorded host, wherever it is grown. Although not yet recorded as a pest in pineapple plantings of the continental areas of the Western Hemisphere, it is included in this paper as an aid to identification should it be found in this geographic area at a later date. It is of interest to note that Bianchi (1940) found *Podothrips lucasseni* Krüg to be a natural predator of S. *ananas* in Hawaii, although his mention of *Vallota insularis* (Amaryllidaceae) as the plant host involved leaves some question as to his correctly identifying the mite.

Steneotarsonemus fulgens, new species

(Plates 5, 18 and 22)

Male: Body broad, oval, broadest at anterior condyles of coxae III; legs of moderate length, anterior pairs subequal in size, posterior pairs well-developed. Apodemes conspicuous and well-defined; apodemes I and II subparallel; anterior median apodeme weak for a short distance at point midway between its anterior extremity and main body suture. Posterior apodemes strongly sclerotized; apodemes III and IV subparallel for most of their lengths, apodemes III curving gently inward at anterior thirds, intersecting apodemes IV to form a scalloped anterior margin for interapodemal area, this margin located a distance equal to length of genu I behind main body suture. Cephalothoracic shield with anterior margin broadly truncate, as broad as capitulum. *Dorsal chaetotaxy:* Four pairs of dorsal propodosomal setae in linear arrangement; setae of second pair shorter than others; setae of fourth pair slightly longer than second setae, slightly shorter than setae of first pair; third pair of setae about twice as long as first pair. Four pairs of dorsal hysterosomal setae, those of first pair slightly longer than second and third pairs, fourth pair shortest. *Ventral chaetotaxy:* First pair of ventral propodosomal setae minute, length equal to one half basal width of tarsus I, situated slightly more than length of seta behind apodemes I, this distance laterad from median apodeme. Second pair of ventral propodosomal setae about twice length of first setae, located near centers of areas defined by apodemes II, median apodeme and main body suture. First and second pairs of ventral hysterosomal setae subequal in size, length equal to length of fourth dorsal propodosomal setae; setae of first pair located one third length of seta behind apodemes III at their anterior thirds; setae of second pair situated slightly laterad from apodemes IV at their midlengths. *Capitulum:* Subcordate with posterior margin rounded truncate. Dorsal setae with length equal to one half greatest width of capitulum, situated near lateral margins at anterior third of capsule. Ventral setae half as long as dorsal setae, separated from each other by a distance equal to one and one-half times length of seta. Palpi stout, indistinctly segmented, with angularly truncated apices. Chelicerae styliform, projecting between and beyond palpi; cheliceral sheaths not annulated. Length of capitulum including projecting palpi, 48μ; greatest width, 38μ. *Legs:* Anterior pairs with lengths nearly equal to width of body at main body suture. Leg I with coxa subquadrangular, broader than long, without vestiture; femur slightly longer than broad, with two setae; genu slightly longer than broad, with four setae; tibia about one and one-third times as long as broad at base tapering slightly toward apex, segment with three normal setae and one short, dorsal, peglike, sensory seta; tarsus twice as long as broad at base, tapering to bluntly rounded apex, with six normal setae, one short, clavate, sensory seta; tarsus surmounted by a short pretarsus bearing a broad empodium and a short, curved claw. Leg II similar to leg I in size and chaetotaxy, except genu has three rather than four setae, tibia lacks a sensory peglike seta and has four normal setae, pretarsus has two curved claws. Leg III with coxa subtriangular, about twice as long as broad, without vestiture; femur about twice as long as broad, partially divided at about mid-length by an incomplete suture, segment with one seta; genu about two thirds as long as femur, with three setae; tibia slightly longer than genu, with four setae; tarsus slender, elongate, tapering from base to narrowly rounded apex, segment with three setae; tarsus bearing at its apex a short, narrow pretarsus which supports two spreading, curved claws and a broad, bilobed empodium. Leg IV with coxa subtriangular, broader than long, with one ventral seta; femur stout, nearly twice as long as broad at base, with a broad quadrangular flange occupying apical three fourths of inner margin, segment with two long and one short setae; tibia nearly twice as long as broad at base, outer margin convex, segment with one stout seta twice as long as segment located ventrally near outer apical margin, one rodlike seta one half as long as segment located dorsally near outer apical margin; tarsus twice as broad as long, with three setae, and bearing at its apex a long, slender, curved claw. *Genital papilla:* Length, 38μ; greatest width 44μ; subcordate with posterior margin truncate. *Measurements:* Length from tips of palpi to apex of genital papilla, 244μ; width of body at anterior condyles of coxae III, 139μ; anterior margin of cephalothoracic shield to main body suture, 65μ.

Female: Body broad, oval, broadest at mid-length. Apodemes inconspicuous, not clearly defined; apodemes I short and weakly sclerotized, extending posteromedially from inner condyles of coxae I, intersecting medially at anterior extremity of median apodeme; apodemes II subparallel to apodemes I, extending from inner condyles of coxae II nearly to median apodeme, anterolateral portions of apodemes strongly sclerotized and conspicuous; median apodeme strongly sclerotized from point near anterior extremity to point in line with posteromedial extremities of apodemes II, apparent only as an indistinct line from this point to main body suture. Posterior apodemes indistinct, those of legs III extending anteromedially from anterior condyles of coxae III, becoming indistinct after a short distance; apodemes IV apparent as thin, obscure lines extending anteromedially from anterior condyles of coxae IV for a short distance; posterior median apodeme visible for a short distance at position in line with anterior extremities of apodemes IV. Hysterosoma indistinctly segmented, one suture at coxae IV, one suture midway between coxae IV and apex of body. Pseudostigmatic organs with expanded apices subcircular in outline, narrow pedicel with length about equal to diameter of expanded apex. Stigmatal openings distinct, located slightly behind anterolateral angles of cephalothoracic shield. Tracheae indistinct. *Dorsal chaetotaxy:* First pair of dorsal propodosomal setae with length slightly greater than one half length of capitulum, located between stigmatal openings and anterolateral angles of cephalothoracic shield. Second pair of dorsal propodosomal setae about one and one-half times as long as setae of first pair, situated slightly behind and above areoli of pseudostigmatic organs. Five pairs of dorsal hysterosomal setae, first two pairs between coxae IV and main body suture, others on opisthosoma. *Ventral chaetotaxy:* Anterior pair of ventral propodosomal setae with length nearly equal to basal width of tibiotarsus I, situated just behind apodemes I at their mid-lengths. Second pair of ventral propodosomal setae twice as long as setae of first pair, located slightly behind apodemes II at their mid-lengths. First pair of ventral hysterosomal setae subequal in length to second ventral propodosomals, located between anterior extremities of apodemes III and median apodeme. Second pair of ventral hysterosomal setae slightly shorter than those of first pair, located on apodemes IV the length of seta from anterior condyles of coxae IV. *Capitulum:* Subcordate with posterior margin rounded truncate. Length including palpi, 44μ; greatest width, 38μ. Dorsal setae with length equal to one half length of capitulum. Ventral setae nearly as long as dorsal setae. Palpi long, indistinctly segmented, sides subparallel, angularly truncate at apex. Chelicerae styliform, extending to tips of palpi; cheliceral sheaths not striated. *Legs:* Anterior pairs subequal in size. Leg I with coxa subquadrangular, broader than long, without vestiture; femur slightly longer than broad, with three setae; genu slightly longer than broad at base, tapering from base toward apex, with four setae; tibiotarsus one and one-half times as long as genu, three times as long as broad at base, tapering slightly to broadly rounded apex, segment with twelve normal setae, one long, rodlike seta, two clavate, annulated, sensory setae; tarsus terminating in a short pretarsus bearing a single, strong, curved claw and a broad empodium. Leg II with coxa and femur similar in size and chaetotaxy to those of leg I; genu slightly broader at base than long, with one stout, lanceolate seta located dorsally near inner margin at base, two normal setae; tibia slightly longer than broad, sides subparallel, with four long setae; tarsus as long as tibia, tapering from base to narrowly rounded apex, with four normal setae and one clavate, annulated seta located dorsally near inner margin at basal fourth of segment; tarsus surmounted by a slender, short pretarsus bearing at its apex two long, curved, spreading claws between and beyond which projects a broad, bilobed empodium. Leg III with coxa slender, elongate, as long as combined lengths of genu, tibia and tarsus of leg II, segment without ornamentation; femur three fifths as long as coxa, divided at basal third by an incomplete suture, basifemur subcircular in outline, telofemur with sides diverging toward apex, bearing four setae; tibia nearly as long as femur, lateral margins convex, with four setae; tarsus slender, elongate, nearly as long as tibia but one fourth as broad, segment with four setae; tarsus surmounted by narrow pretarsus one third as long as tarsus, bearing two stout, curved, spreading claws and a broad, bilobed empodium. Leg IV with coxa small, subtriangular, as broad as long, without setae; trochanter short, collarlike, broader than long, without vestiture; third segment slightly bowed, as long as combined lengths of femur and genu I, with one seta one fourth as long as segment located ventrally near base on outer margin, one seta one half as long as segment located ventrally near apex on outer margin; fourth segment one half as long as third segment, with subterminal seta slightly longer than segment, terminal seta more than twice as long as segment. *Measurements:* Apex of cephalothoracic shield to tip of opisthosoma, 213μ; tip of shield to main body suture, 61μ; width of body at main body suture, 139μ.

Types: Beaver Lake, Washington, July 27, 1950, in eriophyid galls on *Salix* sp.

Location of types: Holotype male, allotype female, two male paratypes, ten female paratypes in Snow Entomological Museum, University of Kansas. Three male and five female paratypes at United States National Museum, Washington, D. C.

At the present time this species is known from a single collection in which they were found to be abundant in galls on willow leaves. The galls also contained many eriophyid mites which probably were responsible for the gall formation. However, it seems apparent that the tarsonemids were feeding on the malformed tissues of the gall rather than upon fungi or other such material.

This species bears a close morphological resemblance to S. *pallidus* from which females may be distinguished by the absence of the strong lanceolate seta of femur I, which is present in S. *pallidus*. Males of these two species are readily distinguished by differences in the size and shape of the femoral flange of leg IV and the chaetotaxy of tarsus I.

Steneotarsonemus chionaspivorus (Ewing), new combination

(Plates 7, 19 and 23)

Tarsonemus chionaspivorus Ewing, 1911, Psyche, vol. 18, no. 1, p. 40; Ewing, 1939, U. S. Dept. Agr. Tech. Bull., 653, p. 24.

Tarsonemus approximatus Banks, 1914, Jour. Ent. and Zool., vol. 6, no. 2, p. 55; Quayle, 1912, California Agr. Exp. Sta. Bull., 234, p. 503 (*Tarsonemus approximatus* Banks, M. S.); Garman, 1917, Maryland Agr. Exp. Sta. Bull., 208, p. 327.

Tarsonemus floricolus, Ewing, 1939 (not Canestrini and Fanzago, 1876), U. S. Dept. Agr. Tech. Bull., 653, p. 30 (new synonymy).

Male: Body broad, oval, broadest at anterior extremity of coxa III; legs moderately short and stout; all apodemes distinct and well-defined; genital papilla nearly as large as capitulum, slightly longer than broad. Apodemes I as long as tibia I, extending in posteromedial directions from inner condyles of coxae I, converging to form Y-shaped juncture with median apodeme at point slightly posterior to hind extremities of coxae I. Apodemes II twice as long as apodemes I and subparallel to the latter, their medial extremities curving abruptly caudad just before intersection with median apodeme and losing definity shortly thereafter. Anterior median apodeme distinct for its entire length, extending from Y-shaped juncture of apodemes I to intersection with transverse apodeme. Transverse apodeme strong and distinct, transecting body at point the length of tarsus I behind medial extremities of apodemes II. Posterior apodemes distinct, those of leg III extending in anteromedial directions from anterior extremities of coxae III for a distance equal to the length of coxa III, curving gently mesad at this point and continuing to intersection with apodemes IV. Apodemes IV subparallel to apodemes III, their anterior extremities curved in a like manner and converging mesally at a point the length of coxa III behind transverse apodeme. Posterior median apodeme well-defined from point of juncture of apodemes IV to a point in line with inner anterior extremities of coxae IV, becoming obscure posterior to this point. A distinct hysterosomal suture transects body at hind extremities of coxae III. Anterior margin of propodosomal shield broadly truncate and projecting to cover basal third of the broad capitulum. *Dorsal chaetotaxy:* Propodosoma with four pairs of dorsal setae, the first three pairs in linear arrangement; first pair with length equal to one half greatest width of capitulum, situated one half length of seta behind anterior margin of propodosoma and separated from each other by a distance nearly equal to length of seta; setae of second pair four fifths as long as first setae, situated at points four fifths their length behind and slightly laterad from first setae; third pair of setae slightly longer than propodosoma and three times as long as setae of first pair, situated behind and slightly laterad from setae of second pair a distance slightly greater than that separating first and second setae; fourth pair of setae about as long as setae of second pair, situated laterad and slightly posterior to third setae, separated from the latter by a distance equal to one third length of fourth seta. Hysterosoma with first, second and third pairs of setae subequal in size, slightly longer than first propodosomal setae; fourth pair of dorsal hysterosomal setae one half as long as third pair and located near margins of genital papilla at its mid-length, separated from each other by a distance nearly equal to twice length of seta. *Ventral chaetotaxy:* First pair of ventral propodosomal setae as long as basal width of tarsus I, located three fourths length of seta laterad from juncture of apodemes I; second pair of setae with size subequal to setae of first pair, situated the length of seta laterad from medial extremities of apodemes II. First pair of ventral hysterosomal setae as long as ventral propodosomals, located near anterior extremity of interapodemal area defined by apodemes III and IV; second pair of ventral hysterosomal setae slightly longer than setae of first pair, located just laterad to apodeme IV, twice length of seta from posterior extremities of apodemes IV. *Capitulum:* Broadly subcordate, with posterior margin rounded truncate and having the suggestion of a slight medial emargination. Length, including projecting palpi, 37μ; greatest width, 39μ. Dorsal setae short, their combined lengths equal to two thirds width of capitulum, located dorsally on anterolateral margins of capsule. Ventral setae slightly shorter than dorsal setae and occupying a ventral position in transverse line with dorsal setae but more approximate to one another. Palpi short and stout, indistinctly segmented, projecting slightly beyond broadly rounded forward extremity of capitulum. Chelicerae short, styliform, not projecting beyond tips of palpi; cheliceral sheaths without striae. *Legs:* Anterior pairs moderately short and stout, legs I larger than legs II; legs III more slender than anterior pairs; legs IV greatly enlarged. Leg I with coxa rectangular, broader than long, without setae; femur short, nearly as broad as long, with four normal setae; genu as broad as long, with four setae; tibia slightly longer than genu, longer than broad, with one peglike, annulated seta having a length equal to one half basal width of segment, situated dorsally near outer margin at basal third of segment, one short, clavate, annulated seta one-half as long as the former seta, located dorsally near outer margin at mid-segment, five normal setae; tarsus as long as tibia, tapering toward narrowly rounded apex, with one clavate, annulated seta having a length equal to one half basal width of segment, located dorsally one half length of seta from base of segment on its outer margin, seven normal setae; tarsus surmounted by a short, narrow pretarsus bearing a small claw and small empodium. Leg II with coxa subquadrangular, twice as broad as long, without setae; femur robust, nearly as broad as long, with two setae; genu as broad as long, one half as long as femur, with three setae; tibia three fifths as broad at base as long, with four normal setae; tarsus slender, elongate, tapering from base to narrowly rounded apex, segment as long as tibia, with one short, annulated, sensory seta having length equal to two thirds basal width of segment, located dorsally near inner basal margin of segment, four normal setae; tarsus surmounted by a slender pretarsus with serrated margins, its length equal to two thirds the length of tarsus and bearing at its apex two small, curved, spreading claws between and beyond which projects a broad empodium. Leg III with coxa broadly oval, as long as combined lengths of genu, tibia and tarsus II, greatest breadth about one half the length of segment, without vestiture; femur robust, as long as width of coxa, not divided by a suture, with one normal seta; genu short, broader than long, with three setae; tibia about twice as long as broad, tapering slightly from mid-segment to apex, with four setae; tarsus nearly as long as tibia, tapering from base to narrowly rounded apex, with three setae; tarsus surmounted by a slender pretarsus, one half as long as tarsus, and a broad empodium, the pretarsus bearing apically a pair of small, curved, spreading claws. Leg IV with coxa subquadrangular, more than twice as broad as long, with one small ventral seta located near outer margin; femur stout, breadth at base equal to three fifths length of segment, width of apex one third width at base, outer margin of segment strongly convex, segment bearing one dorsal seta having length equal to one and one-half times apical width of segment and situated near outer margin the length of seta from apex of segment, one ventral seta slightly shorter than dorsal seta situated near inner margin at basal two fifths of segment, another ventral seta, twice as long as the former, situated near inner margin one half length of seta from apex of segment; tibia robust, width at base equal to two thirds length of segment, inner margin slightly concave, outer margin slightly convex, with one clavate, annulated, sensory peg, its length equal to two thirds apical width of segment, situated dorsally near outer margin just before apex, one long, tactile seta nearly as long as leg IV, located ventrally at mid-segment near apex; tarsus broader than long, with one ventral seta twice as long as segment, located near inner margin, one dorsal seta with size subequal to ventral seta, situated near inner margin, one short dorsal seta located near mid-segment; leg IV terminated by a long, strong, curved claw, its length equal to length of tibia. *Genital papilla:* Broadly subcordate with rounded anterior margin deeply emarginate; length, 36μ; width, 36μ. *Measurements:* Length, from tips of palpi to apex of genital papilla, 214μ; width of body at anterior condyles of coxae III, 122μ; main body suture to tips of palpi, 77μ; anterior margin of propodosoma to main body suture, 53μ; width of body at main body suture, 87μ.

Female: Body broadly oval, broadest at mid-length. Legs relatively small and slender, the anterior pairs subequal in size, legs IV not extending to margins of body and with the innermost margins of their coxae separated by a distance equal to one and one-half times the length of coxa IV. Apodemes weak and inconspicuous, those of legs I as long as genu I, extending in nearly mesad directions from innermost angles of coxae I, converging to form a broad, Y-shaped juncture with the anterior extremity of median apodeme. Apodemes II one and one-half times as long as apodemes I and extending in posteromedial directions from innermost angles of coxae II, terminating at points the width of genu I laterad from median apodeme. Transverse apodeme weak and indistinct, transecting body in a smooth uninterrupted arc slightly anterior to main body suture, the lateral extremities situated just posterior to the posterior basal angles of coxae II. Anterior median apodeme weak and indistinct extending from point of juncture of apodemes I to point in transverse alignment with mesal extremities of apodemes II. Apodemes III and IV not clearly defined. Posterior median apodeme indicated only as a faint mesal line, situated in transverse alignment with coxae III and approximately as long as coxa III. Dorsum of propodosoma projected anteriorly to form a hood which extends over basal fourth of capitulum, the anterior margin of hood truncate and equal to width of capitulum. Pseudostigmatic organs with expanded apices broadly oval and supported by slender pedicels with length equal to width of expanded apical portion. Stigmatal openings distinct, situated dorsolaterally midway between pseudostigmatic organs and anterolateral angles of hood. *Dorsal chaetotaxy:* First pair of dorsal propodosomal setae with length equal to one half width of capitulum, situated one half length of seta behind anterior margin of cephalothoracic hood and separated from each other by a distance nearly equal to their combined lengths; second pair of setae about twice as long as first setae, situated one half length of seta anterior to main body suture, this distance from lateral margins of body. First and second dorsal hysterosomal setae as long as first dorsal propodosomals; third, fourth, fifth and sixth pairs of setae subequal in size, about two thirds as long as first dorsal propodosomals. *Ventral chaetotaxy:* First pair of ventral propodosomal setae as long as basal width of tibiotarsus I, located the length of seta laterad from juncture of apodemes I; second ventral propodosomals twice as long as setae of first pair, situated on apodemes II at about mid-lengths of apodemes. First ventral hysterosomals as long as second ventral hysterosomals, located the length of seta behind main body suture and separated from each other by a distance equal to two and one-half times length of seta; second ventral hysterosomals as long as setae of first pair, located three fourths length of seta from inner margins of coxae III at the posterior two fifths of these segments; third pair of setae one half as long as sixth dorsal propodosomals, located near apex of hysterosoma. *Capitulum:* Relatively small and subcordate, with posterior margin slightly emarginate; length, including projecting palpi, 38μ greatest width, measured at posterior third of capsule, 28μ. Dorsal setae with length equal to two fifths greatest width of capitulum, situated near anterolateral margins of capsule. Ventral setae two thirds as long as dorsal setae, situated near bases of palpi and separated from each other by a distance equal to length of seta. Palpi relatively long and moderately stout, indistinctly segmented and ornamented. Chelicerae short and styliform, projecting between but not beyond palpi; cheliceral sheaths without transverse striae. *Legs:* Leg I with coxa robust, subquadrangular, slightly broader than long, without vestiture; femur one and one-half times as long as broad, with three setae; genu one and one-half times as long as broad, with four setae; tibiotarsus nearly twice as long as genu, about four times as long as broad at base, with one short, clavate, annulated seta having length equal to one half basal width of segment, located dorsally near outer margin the length of seta from base of segment, one clavate, annulated seta with length equal to basal width of segment, located dorsally near outer margin at about mid-segment, ten normal setae; tarsus surmounted by a short, narrow pretarsus which subtends a small empodium and a curved claw. Leg II with coxa subquadrangular, as broad as long, without vestiture; femur one and one-half times as long as broad, with three setae; genu as broad as long, with three setae; tibia one and one-third times as long as genu, with four setae; tarsus slender, elongate, as long as genu, three times as long as broad at base, tapering to narrowly rounded apex, with one clavate, annulated seta having length equal to basal width of segment, situated dorsally on outer margin near base of segment, four normal setae; tarsus surmounted by a short, slender pretarsus which bears at its apex two small, curved, spreading claws and a small empodium. Leg III with coxa slender, elongate, length equal to combined lengths of genu and tibiotarsus I, about one fourth as broad as long, without vestiture; femur slightly less than one half as long as coxa, with basifemur subglobose and separated from telofemur by a strong constriction and an incomplete suture at basal two fifths of segment, telofemur expanding from its base to apex and with three setae; tibia as long as femur, two and one-half times as long as broad at base, with four setae; tarsus slender, elongate, nearly as long as tibia, with three setae; tarsus surmounted by a short pretarsus having imbricated margins and subtending two small, curved, spreading claws between which projects a small, bilobed empodium. Leg IV with coxa subtriangular, slightly longer than broad, without vestiture; trochanter collarlike, one and one-half times as broad as long, without setae; third segment relatively short and slender, its length about equal to length of femur III, with one ventral seta one third as long as segment, located on outer margin near base, one ventral seta one third as long as segment, situated near outer margin at apical fifth of segment; fourth segment three fifths as long as third segment, with one stout ventral seta as long as third segment, situated near outer margin at apical third, one terminal seta as long as leg IV. *Measurements:* Length, from tips of palpi to apex of hysterosoma, 206μ; anterior margin of cephalothoracic hood to apex of hysterosoma, 177μ; anterior margin of hood to main body suture, 52μ; width of body at main body suture, 96μ; width of body at anterior condyles of coxae III, 107μ; width at coxae IV, 107μ; distance between anterior condyles of coxae III, 50μ; distance between innermost margins of coxae IV, 12μ.

Types: Originally described from specimens of both sexes collected at Ames, Iowa, July 25, 1910, by H. E. Ewing, on poplar infested with oystershell scale.

Location of types: Unknown.

The description of the male given above was made from a specimen which was remounted from a slide identified with the following data in the handwriting of the author of this species: "*Tarsonemus chionaspivorus* Ewing, male, feeding on eggs of *Coccus longulus* ?, Pomona, California, July 2, 1912, Neuls." Since this specimen was identified by its original describer, it seems reasonable to accept this determination as correct, especially since the whereabouts of the type series remains a mystery and so precludes comparison with other specimens. The female description was made from one of the Brooklyn Botanical Garden specimens identified below. Additional material examined by the present author and identified as this species includes specimens with the following data: U. C. greenhouse, Berkeley Calif., Sept. 16, 1949, R. E. Beer, from azalea (one male); Brooklyn Bot. Gardens, N. Y. City, N. Y., Aug. 8, 1934, F. F. Smith, from decaying buds of *Iris kaempferi* (eleven males and twelve females).

This species bears a very close resemblance to *Tarsonemus setifer* but the stout legs and broad capitulum indicate a closer affinity with the genus *Steneotarsonemus.* In the male it can be readily distinguished from members of the Setifer Group of the genus *Tarsonemus,* with which it is easily confused, by its greatly dilated, robust femora IV and by its broad capitulum.

Genus *Hemitarsonemus* Ewing

Hemitarsonemus Ewing, 1939, U. S. Dept. Agr. Tech. Bull., 653, p. 51.

The characteristics of this genus are redefined as follows: Body of female strongly convex dorsally, male laterally compressed. Female with cephalothoracic shield projected anteriorly covering most of capitulum. Male with inner margin of femur IV never produced to form a flangelike process, often with subapical spurlike projection; combined tibia and tarsus or tibiotarsus IV slender, elongate, incurved, terminal claw well developed or reduced to a small knob.

Type of genus: *Tarsonemus tepidariorum* Warburton (by original designation).

This genus has been involved in considerable controversy prior to the present writing. The sequence of incidents leading up to the confusion in the genus began with the description of *Acarus translucens* by Nietner in 1861. This mite in the opinion of the present author and in the opinion of Ewing (1939) is not a tarsonemid. In 1890 Green described a tarsonemid mite under the name of *Acarus translucens,* the name obviously being a primary homonym. In 1928 Oudemans erected the new genus *Avrosia* which was accompanied by a very poor description of *Acarus translucens* Green together with the designation of the genotype as being *Acarus translucens* Nietner. In 1904 Banks described as a new species *Tarsonemus latus* which was the same mite as Green's *Acarus translucens.* Although Banks' *T. latus* is a synonym of *A. translucens* Green, the former name is resurrected from synonomy to replace Green's homonym. In 1939 Ewing described the genus *Hemitarsonemus* designating as genotype *Tarsonemus tepidariorum* Warburton with *Tarsonemus latus* Banks as an included species in his new genus. Ewing (1939) was aware of the situation caused by Oudemans' (1928) error and for that reason he used *T. tepidariorum* as the type of his new genus *Hemitarsonemus.*

Key to the Species of Hemitarsonemus

Males

1. Leg IV terminating in a strong, curved claw 2
Leg IV with terminal claw reduced to a small tubercle . *latus,* p. 1293
2. Femur IV with inner margin produced to form a subapical spurlike process; coxa IV with one seta . . . . *tepidariorum,* p. 1308
Femur IV with iner margin not produced to form spurlike process; coxae IV without setae . . . . *peregrinus,* p. 1300

Females

1. Tarsus III with claws reduced, exceeded by empodium 2
Tarsus III with claws well-developed, surpassing empodium, *peregrinus,* p. 1300
2. Hysterosoma wth one pair of ventral setae situated between coxae IV; tibiotarsus I without empodium . . . . *latus,* p. 1293
Hysterosoma lacking ventral setae situated between coxae IV; tibiotarsus I with empodium . . . . *tepidariorum,* p. 1308

Hemitarsonemus latus (Banks)

(Plates 15, 21 and 25)

Tarsonemus latus Banks, 1904, Proc. U. S. Natl. Mus., vol. 32, no. 1553, p. 615; Banks, 1915, U. S. Dept. Agr. Rept., 108, p. 108; Moznette, 1925, Quar. Bull. State Plant Board, Florida, vol. 9, no. 3, p. 121; Smith, 1933, U. S. Dept. Agr. Cir., 301, p. 1; Smith, 1935, Jour. Econ. Ent., vol. 28, no. 1, p. 91; Marle, 1944, Tijdschr. over Plantenziekten, vol. 50, no. 2, p. 26.

Acarus translucens Green (not Nietner, 1861), 1890, Rept. Govt. Ent. Dept. Agr., Ceylon, Part I, p. 12.

Tarsonemus translucens (Green), Green, 1913, Rept. Govt. Ent. Dept. Agr., Ceylon, Part IV, p. 2; Rutherford, 1913, Trop. Agr. Peradeniya, vol. 41, no. 6, p. 490; Carpenter, 1918, Phytopath., vol. 8, p. 286: Mann et al, 1920, Agr. Jour. India, vol. 15, p. 282: Hirst, 1921, Proc. Zool. Soc. London, vol. 52, p. 797; Hirst, 1923, Proc. Zool. Soc. London, vol. 54, p. 995; Hutson, 1921, Trop. Agr. Peradeniya, vol. 56, no. 6, p. 378; Kulkarni, 1922, Agr. Jour. India, vol. 17, p. 51; Fajardo and Bellosillo, 1934, Philippine Jour. Sci., vol. 54, no. 4, p. 523.

Hemitarsonemus latus (Banks), Ewing, 1939, U. S. Dept. Agr. Tech. Bull. 653, p. 54; Lavoipierre, 1940, Jour. Ent. Soc. Southern Africa, vol. 3, p. 116; Vrydagh, 1942, Publ. Inst. nat. Etude. agron. Congo Belge. Ser. sci., vol. 28, p. 1; Massee, 1943, Rep. East Malling Res. Sta. (1942), p. 64; Gadd, 1946, Bull. Ent. Res., vol. 37, no. 2, p. 157.

Male: Body short, oval, broadest at mid-length; legs long, spindly; apodemes distinct and well-defined; genital papilla prominent, nearly as large as capitulum, apical horns short but conspicuous. Apodemes I slightly longer than half greatest width of capitulum, extending in posteromedial directions from inner angles of coxae I to point of convergence about in line with middles of posterior margins of coxae I. Apodemes II extending in nearly transverse directions from anterior condyles of coxae II to juncture with median apodeme at point the length of apodeme I behind anterior extremity of median apodeme. Anterior median apodeme well-defined for its entire length, extending from Y-shaped juncture with apodemes I to main body suture, apodemes II joining median apodeme at its mid-length. Posterior apodemes dominating hysterosoma; apodemes III extending in anteromedial directions from anterior condyles of coxae III nearly to main body suture, recurved abruptly at this point and converging on median apodeme at its anterior extremity. Apodemes IV subparallel to apodemes III for most of their lengths, joining median apodeme at point the width of tibia II behind anterior extremity of median apodeme. Posterior median apodeme bifurcate posteriorly, each fork more than half length of median portion of apodeme, terminating at inner angles of coxae IV. *Dorsal chaetotaxy:* Propodosoma with four pairs of dorsal setae; setae of first pair shorter than others, second pair longest, third and fourth pairs subequal in length. Hysterosoma with five pairs of dorsal setae; first pair slightly longer than third pair propodosomal setae, situated the length of seta behind main body suture, one fourth length of seta from lateral margins of body; second pair of setae as long as first pair, located the length of seta behind main body suture, separated from each other by a distance equal to twice length of seta; third pair of setae very stout, one and one-fourth times as long as setae of second pair, situated nearly in line with base of fork of median apodeme, separated from each other by a distance equal to one and one-half times length of seta; fourth pair of dorsal hysterosomal setae as long as second pair, located on lateral margins of body about in line with anterior margin of genital papilla; fifth pair of setae very stout, one and one-third times as long as fourth pair, located at apex of hysterosoma at about mid-length of genital papilla, separated from each other by a distance equal to half length of seta. *Ventral chaetotaxy:* Propodosoma with two pairs of ventral setae; first pair as long as basal width of tarsus I, situated the length of seta laterad from Y-shaped juncture of apodemes I and median apodeme; setae of second pair one and one-half times as long as setae of first pair, located midway between apodemes II and main body suture, twice length of seta from median apodeme. Hysterosoma with three pairs of ventral setae, first pair as long as twice basal width of tarsus II, located the length of seta behind main body suture, separated from each other by a distance equal to three times length of seta; second pair of setae one and one-half times as long as setae of first pair, situated near apodemes IV the length of seta mesad from anterior condyles of coxae III; third pair of setae as long as second pair, located near apodemes IV, two thirds length of seta in anteromedial direction from outer basal condyles of coxae IV. *Capitulum:* Subcordate, posterior margin rounded truncate; length including palpi, 32μ; greatest width, 34μ. Dorsal setae curved, length equal to one fourth greatest width of capitulum, situated near lateral margins at apical third of capitulum. Ventral setae as long as dorsal setae and in transverse line with the latter, separated from each other by a distance equal to three fourths length of seta. Palpi short, stout, indistinctly segmented, subterminal bristles prominent. Chelicerae short, needlelike, projecting beyond tips of palpi. *Legs:* Leg I with coxa broad, quadrangular, nearly twice as broad as long, without setae; femur having length slightly less than width of coxa or slightly more than half greatest width of capitulum, about one and one-half times as long as broad, with three setae; genu one half as long as femur, slightly broader than long, with four setae; tibia about one and one-half times as long as genu and about one and one-half times as long as broad, with lateral margins somewhat convex, with one short, spinelike seta having length equal to half basal width of segment located dorsally near outer margin the length of seta from base of segment, one clavate, annulated seta with length slightly greater than half basal width of segment located dorsally near outer margin at basal third, one short, clavate, annulated seta with length equal to one third basal width of segment situated immediately beside longer clavate seta and five normal setae; tarsus narrow, elongate, one and one-half times as long as tibia, tapering from base to narrowly rounded apex, with one broad, lanceolate, annulated seta as long as basal width of segment located dorsally near outer margin at basal sixth of segment and seven normal setae; tarsus surmounted by very short, inconspicuous pretarsus, bearing at its apex a small curved claw beyond which projects a broad subcircular empodium. Leg II robust, elongate, with coxa short and broad, about two and one-half times as broad as long, without setae; femur slightly longer than width of coxa, length about equal to width of capitulum, twice as long as broad, with three setae; genu about one half as long as femur, as broad as long, with three setae; tibia about one and one-half times as long as genu, sides subparallel, with four setae; tarsus elongate, nearly twice as long as tibia, broad at base, tapering abruptly to narrow extremity, with one very large, lanceolate, annulated seta slightly longer than basal width of segment located dorsally near inner margin at basal sixth of segment and four normal setae; tarsus surmounted by a narrow pretarsus having length equal to one half basal width of tarsus, bearing at its apex two small, spreading, curved claws and a large, broad empodium. Leg III elongate, robust, with coxa subquadrangular, as long as femur II, without setae; femur as long as combined lengths of femur and genu II, three times as long as broad, lateral margins subparallel for most of their lengths, with two setae; genu nearly one half as long as femur, one and one-half times as long as broad, sides subparallel, with three setae; tibia one and one-half times as long as genu, twice as long as broad at base, slightly expanded toward apex, with four setae; tarsus slightly longer than tibia, broad at base, tapering abruptly, segment appearing slender, elongate, with three setae; tarsus terminating in short, narrow pretarsus bearing two small, curved, spreading claws between and beyond which projects a large, broad empodium. Leg IV with coxa rectangular, as broad as long, two thirds as long as femur III, with one stout seta; femur one and one-half times as long as coxa, twice as long as broad at base, tapering abruptly to apical third of segment, inner margin of segment with a large subapical spur projecting at nearly a right angle to segment a distance almost equal to half basal width of femur, segment with one dorsal and two ventral seta; tibiotarsus narrow, elongate, incurved sharply at apical third, length equal to two thirds length of femur, width at base about one sixth length of segment, with one long, tactile seta and four short, spinelike setae; tibiotarsus surmounted by small, blunt, buttonlike claw. *Genital papilla:* Length, 24μ; width, 28μ; subcircular, with posterior margin flattened truncate; a pair of short, caudolaterally directed, hornlike processes projecting from papilla at extremities of truncated posterior margin. *Anal plate:* Large and well defined; triradiate apodemes with expanse equal to two thirds greatest width of genital papilla, angle formed by posterior apodeme and anterior apodeme greater than a right angle; posterior margin of central disc of plate almost reaching to point in line with anterior margin of genital papilla. *Measurements:* Length from tip of capitulum to apex of genital papilla, 168μ; main body suture to apex of genital papilla, 100μ; anterior margin of propodosoma to main body suture, 46μ; width at main body suture, 93μ; width of body between coxae II and III, 97μ.

Female: Body broad, oval, broadest at mid-length. Anterior apodemes distinct, those of legs I as long as width of coxa I, converging medially in line with posterior margins of coxae I. Apodemes II one and one-half times as long as apodemes I, intersecting median apodeme at points the length of genu I behind anterior extremity of median apodeme. Median apodeme extending from Y-shaped juncture of apodemes II to main body suture, apodemes II intersecting median apodeme just anterior to mid-length of the latter. Apodemes III nearly as long as coxae III, extending in anteromedial directions from anterior condyles of coxae III, curving slightly with anterior third of their lengths nearly parallel to main body suture, apodemes terminating indistinctly half their length from mid-body, one and one-half times length of apodeme behind main body suture. Apodemes IV slightly longer than apodemes III, subparallel to posterior portions of apodemes III, curved anteriorly at medial extremities which are separated from each other by distance equal to width of coxa III. Posterior median apodeme present only as a very small, crow's-foot structure, located between and slightly behind median extremities of apodemes IV. Hysterosomal sutures indistinct except for suture transecting body at coxae IV. Pseudostigmatic organs slightly shorter than tarsus II, enlarged apex subcircular, its diameter slightly greater than length of slender pedicel, basal plates two thirds as long as diameter of expanded apex of organ. Stigmatal openings pronounced, located just behind anterolateral angles of propodosoma, diameter of opening equal to one third diameter of apical portion of pseudostigmatic organ; tracheae distinct only for a short distance beyond stigmatal openings; tracheal pouches apparently absent. *Dorsal chaetotaxy:* Propodosoma with two pairs of dorsal setae; first pair stout, length equal to width of femur I, located the length of seta behind anterior margins of propodosoma, separated from each other by a distance nearly equal to combined lengths; setae of second pair weak, two thirds as long as setae of first pair, located twice length of seta from main body suture, this distance from lateral margins of body, about in line with juncture of apodemes II with median apodeme. Hysterosoma with five pairs of dorsal setae; first pair as long as greatest width of femur III, located the length of seta from lateral margins of body, about in line with anterior extremities of apodemes III, this being at about mid-length of first hysterosomal segment; second pair of setae subequal in length to first pair, located at mid-length of first hysterosomal segment, slightly anterior and mesad from anterior coxal condyles of legs III; third pair of setae as long as setae of second pair, situated twice length of seta before penultimate hysterosomal suture, separated from each other by a distance slightly less than distance between anterior condyles of coxae IV; fourth pair of dorsal hysterosomal setae as long as third pair, located on lateral margins of body at base of apical segment of hysterosoma; fifth pair of setae as long as setae of fourth pair, located at apex of hysterosoma, separated from each other by a distance equal to two and one-half times length of seta. *Ventral chaetotaxy:* Propodosoma with two pairs of ventral setae; first pair as long as median width of tibiotarsus I, located one third length of seta behind apodemes I at their median thirds; second pair of setae as long as first pair, situated one half length of setae behind lateral thirds of apodemes II. Hysterosoma with six pairs of ventral setae; first pair with length equal to basal width of tarsus II, located between anterior extremities of apodemes III and main body suture, separated from each other by a distance equal to four times length of seta; second pair of setae slightly longer than setae of first pair, situated on medial extremities of apodemes III; third pair of setae subequal in length to second pair, located at mid-lengths of apodemes IV, these setae and setae of second pair within area delimited by apodemes III and IV; fourth pair of setae slightly longer than setae of second pair, located between coxae IV, separated from each other by a distance equal to their combined lengths; fifth pair of setae slightly longer than fourth pair, located midway between posterior margins of coxae IV and apex of hysterosoma, separated from each other by a distance equal to two and one-half times length of seta, this distance equal to length of tarsus II; sixth pair of setae slightly longer than setae of fifth pair, located at apex of body, separated from each other by a distance about equal to their combined lengths. *Capitulum:* Length including palpi, 35μ; width, 33μ subcordate, with posterior margin truncate. Dorsal setae with length equal to one fourth greatest width of capitulum, located on margins of capsule at apical fourth. Ventral setae as long as dorsal setae, situated in region of apical third of capitulum, separated from each other by a distance equal to three fourths length of seta. Palpi robust, broadly rounded apices projecting a short distance beyond tip of capitulum. Chelicerae styliform, projecting between tips of palpi; cheliceral sheaths conspicuous, without striae. *Legs:* Anterior pairs rather small in comparison with size of body. Legs I and II assembled in anterior two thirds of small propodosoma, inner margins of coxae II separated by a distance slightly less than greatest width of capitulum. Leg I of moderate length, about as long as one half width of body at main body suture, with coxa subquadrate and without setae; femur as long as coxa, one and one-third times as long as broad at base, tapering slightly from base to apex, with three setae; genu two thirds as long as femur, as broad at base as long, tapering slightly from base to apex, with four setae; tibiotarsus broad, elongate, one and one-half times as long as femur, three and one-half times as long as broad at base, tapering slightly from base to broadly rounded apex, with one long, annulated seta as long as basal width of segment located near outer margin at basal third, one short, clavate, annulated seta near base of segment on outer margin, one short, lanceolate, annulated seta near base of segment on outer margin and twelve normal setae; tibiotarsus surmounted by a single stout claw, directed at nearly a right angle to tarsus, its length about equal to one fourth length of tarsal segment. Leg II longer than leg I, with coxa subtriangular, slightly broader than long, without setae; femur as long as combined lengths of femur and genu I, about two and one-fourth times as long as greatest breadth, tapering slightly from base to apex, with three setae; genu slightly more than one third as long as femur, about as long as broad, with three setae; tibia one and one-half times as long as genu, sides subparallel, with four setae; tarsus narrow, elongate, tapering abruptly from base, its length one and one-third times length of tibia, four times as long as broad at base, with one long, dorsal, clavate, annulated seta slightly more than one third as long as segment located near inner margin at base and four normal setae; tarsus surmounted by a short pretarsus, its length equal to one half basal width of segment, bearing at its apex two small, spreading claws between and beyond which projects a broadly rounded empodium. Leg III with coxa broad, elongate, as long as femur II, slightly more than twice as long as greatest breadth, outer margins convex, without vestiture; femur nearly as long as coxa, expanded from base to apex, with five setae; tibia slightly longer than femur, nearly four times as long as broad at base, tapering slightly to apex, with four setae; tarsus narrow, elongate, nearly as long as tibia, lateral margins subparallel, with four setae; tarsus terminated by a short, imbricated pretarsus, as long as basal width of tarsus, bearing at its apex two small, spreading claws between and beyond which projects a broadly rounded empodium. Leg IV with coxa subtriangular, slightly broader than long, width equal to width of coxa III, without setae; trochanter collarlike, twice as broad as long, without setae; third segment narrow, elongate, as long as coxa III, with one ventral seta one fourth as long as segment located near inner margin half length of seta from base, one ventral seta one third as long as segment situated on inner margin one third length of seta from apex of segment; fourth segment narrow, elongate, four fifths as long as third segment, with a stout, subapical seta as long as segment situated on inner margin at apical sixth of segment, apical seta nearly as long as leg IV. *Measurements:* Anterior margin of propodosoma to apex of hysterosoma, 186µ; tip of propodosoma to main body suture, 59µ; width of body at main body suture, 139µ; width at coxae III, 159µ; distance between anterior condyles of coxae III, 66µ.

Types: Washington, D. C., on young shoots of mango in greenhouse.

Location of types: Unknown.

Living specimens of males of this species are rather easily distinguished from any of the known males in previous genera, even with only the low power magnification of a hand lens. The long, spindly hind legs which are carried in a semierect position are quite characteristic and are readily seen. Living females are often a pale or dark green color with a conspicuous longitudinal middorsal stripe in the shape of an hourglass which is white in color.

This species may be readily distinguished from other members of the family Tarsonemidae discussed in this paper by the presence, in the male, of a ventral hysterosomal seta situated in the interapodemal area delimited by apodeme IV and the posterior median apodeme, and in the female, by the presence of an extra pair of ventral hysterosomal setae situated between coxae IV.

The present writer has studied specimens of this species accompanied by the following data: U. C. greenhouse, Berkeley, Calif., Sept. 12, 1941, E. O. Essig, curling leaves of *Vigna sesquapedata;* U. C. greenhouse, Berkeley, Calif., Sept. 19, 1949, R. E. Beer, African marigold; Dacca, India, G. M. Das, on jute; Manilla, P. I., Oct. 22, 1932, T. G. Fajardo, on dahlia; Taihoku, Formosa, Jan. 10, 1939, R. Takahashi, on tobacco leaf; Puerto Rico, Feb. 10, 1939, Arturo Roque, on peppers; Dom. Ent. Lab., Vineland Sta., Ontario, Dec. 14, 1939, G. G. Dustan, on tomato; Belgian Congo, Sept. 25, 1947, R. W. Harned, on cotton leaves; Peamoho, Oahu, Oct. 18, 1940, W. C. Look, papaya; Kailua, Oahu, Feb. 8, 1940, W. C. Look, papaya; Guam, Apr. 28, 1938, R. G. Oakley, on tomato plant; St. Groex, Virgin Is., Dec. 31, 1931, C. E. Wilson; Bahia, Brazil, April 22, 1928, G. Bondar, on *Phaseolus vulgaris;* Campinas, S. Paulo, March, 1938, E. J. Hambleton, on cotton.

The species is a very destructive plant feeder with a rather extensive host range and wide distribution. It is known to occur in Australia, Asia, Africa, Europe, North America, South America and the Pacific Islands.

Hemitarsonemus peregrinus, new species

(Plates 15, 21 and 25)

Male: Body short, diamond-shaped, broadest at about mid-length. Apodemes distinct and clearly defined, those of legs I as long as genu I, extending in posteromedial directions from innermost angles of coxae I converging medially. Apodemes II as long as tarsus I, subparallel to apodemes I for most of their lengths, extending from inner angles of coxae II to about caudal third of median apodeme, curved abruptly in posterior direction at medial fifth of their lengths, terminating indistinctly just laterad from median apodeme the length of genu I in front of main body suture. Anterior median apodeme extending from point in line with hind margins of coxae I to main body suture, its anterior extremity at Y-shaped juncture of apodemes I, posterior half less distinct than anterior half of its length. Apodemes III conspicuous, extending in anteromedial directions from anterior extremities of coxae III in forward directed arc, intersecting apodemes IV at their anterior extremities, anteromedial half of apodemes less distinct than remainder of length.

Apodemes IV linear, extending from outer basal angles of coxae IV to points one half length of genu I laterad from anterior extremity of median apodeme. Posterior median apodeme extending from point one fourth length of genu I behind main body suture to point in line with bases of coxae IV, not bifurcate caudally. Dorsum of propodosoma not prolonged anteriorly to form a cephalothoracic shield, its anterior margin in line with posterior margin of capitulum. *Dorsal chaetotaxy:* Propodosoma with four pairs of dorsal setae; first pair about twice as long as tarsus II, located the length of genu I behind anterior margin of propodosoma, separated from each other by this distance; setae of second pair as long as tibia I, located two thirds length of seta behind and slightly laterad from setae of first pair, equidistant from setae of first and third pairs; third pair of setae one and two-thirds times as long as setae of first pair, situated two thirds length of second seta behind and slightly laterad from the latter; setae of fourth pair two thirds as long as setae of second pair, located one half length of seta laterad from and slightly behind setae of third pair. Hysterosoma with four pairs of dorsal setae; first pair slightly more than twice as long as third pair of dorsal propodosomal setae, located near lateral margins of body two thirds the distance from main body suture to anterior extremities of coxae III; second pair of setae as long as tibia III, situated near lateral margins of body about in line with hind extremities of coxae III; setae of third pair one half as long as setae of second pair, located the length of seta from caudolateral margins of body, in line with posterior extremities of coxae IV, separated from each other by a distance nearly equal to three times length of seta; fourth pair of setae as long as third pair, located on caudolateral extremities of hysterosoma, beside apical fourth of genital papilla. *Ventral chaetotaxy:* Propodosoma with two pairs of ventral setae; first pair as long as tibia II, located the length of seta laterad from Y-shaped juncture of apodemes I; setae of second pair subequal in length to setae of first pair, situated the length of seta behind apodemes II, one and three-fourths times length of seta from median apodeme. Hysterosoma with two pairs of ventral setae; first pair as long as genu I, located one and one-fourth times length of seta laterad from anterior extremities of apodemes IV, this being one and one-half times length of seta behind main body suture; setae of second pair one and one-fourth times as long as setae of first pair, situated in interapodemal areas delimited by apodemes III and IV, one third length of seta from apodemes IV at their posterior thirds. *Capitulum:* Subcordate with posterior margin truncate;

length including projecting palpi, 34μ; greatest width, 27μ. Dorsal setae as long as tibia II, situated near lateral margins at about apical third of capitulum. Ventral setae slightly longer but not as stout as dorsal setae, located very nearly opposite the latter. Palpi short, indistinctly segmented, short subterminal bristles as long as width of palpus at apex. Chelicerae short, needlelike, extending to tips of palpi. *Legs:* Anterior pairs slender, elongate, first pair slightly longer than second pair. Leg I with coxa subquadrangular, nearly twice as broad as long, without setae; femur with length equal to greatest width of capitulum, about twice as long as broad at base, sides subparallel for most of their lengths, with four setae; genu one third as long as femur, slightly broader than long, with four setae; tibia one and two-thirds times as long as genu, with one lanceolate seta one third as long as segment located dorsally near outer margin at mid-segment, one short, clavate seta with length equal to one sixth basal width of segment located slightly mesad to lanceolate seta, four normal setae; tarsus slender, elongate, twice as long as tibia, six times as long as broad at base, tapering slightly to truncate apex, with one clavate, annulated seta located mid-dorsally at basal two fifths, eight normal setae, segment with a short rodlike spur with length equal to one third basal width of segment located ventrally near inner margin at apex; tarsus surmounted by a short pretarsus bearing a broad empodium beyond which projects a stout, curved claw. Leg II with coxa subquadrangular, one and one-half times as broad as long, without setae; femur as long as but slightly more slender than femur I, width at apex slightly more than one third length of segment, with three setae; genu one third as long as femur, as broad as long, with three setae; tibia one and one-half times as long as genu, one and one-half times as long as broad, with four setae; tarsus slender, elongate, as long as tarsus I, four times as long as broad at base, with one large, ovate, annulated seta having length equal to three fourths basal width of segment located middorsally one half length of seta from base, four normal setae, segment with a short, rodlike spur with length equal to one third basal width of segment situated near inner margin at apex; tarsus surmounted by a short pretarsus, its length equal to one half basal width of tarsus, bearing at its apex two large, curved, spreading claws between and beyond which projects a broad, subcircular empodium. Leg III with coxa slender, elongate, length equal to combined lengths of femur and genu I, one third as broad as long, without vestiture; femur as long as tarsus II, three times as long as broad, basal two fifths expanded bulbous, lateral margins diverging from basal two fifths to apex, with one seta; genu as long as genu II, as broad as long, with three setae; tibia two and one-fourth times as long as genu, lateral margins subparallel, with four setae; tarsus slender, elongate, one and one-half times as long as tibia, tapering from base to narrowly rounded apex, with three setae and one short, rodlike spur having length equal to one third basal width of segment located near outer margin at apex; tarsus surmounted by a short pretarsus, its length equal to basal width of tarsus, bearing at its apex two large, spreading, curved claws between which projects a broad, subcircular empodium. Leg IV with coxa subtriangular, one and one-third times as long as broad, length equal to length of tibia I, without setae; femur slender, elongate, its length equal to combined lengths of three apical segments of leg I, greatest width about one fifth length, outer margin slightly convex for basal two thirds, inner margin deeply concave at apical fourth the remainder subparallel to outer margin, with one dorsal seta having length equal to three fourths apical width of segment located near outer margin the length of seta from apex, one ventral seta as long as dorsal seta located near inner margin one and two-thirds times length of seta from base, one stout ventral seta two fifths as long as segment located near outer margin at apical third; tibia one third as long as femur, three times as long as broad at base, outer margin straight for most of its length, curved inward the distal width of segment before apex, inner margin deeply concave, one stout seta as long as segment located ventrally near outer margin at apex, one minute peglike seta with length equal to one third apical width of segment located dorsally on outer margin the length of seta from apex of segment; tarsus as long as apical width of tibia, as broad as long, with one minute dorsal seta one third as long as segment located near inner margin at mid-segment, one small seta with length equal to one third length of segment located ventrally near inner margin at mid-segment; tarsus surmounted by long, slightly curved, pointed claw one and one-half times as long as tarsus, about four times as long as broad at base. *Genital papilla:* Length, 26μ; width, 28μ; subquadrangular, with anterior margin emarginate, two prominent, short horns projecting from posterolateral angles. *Measurements:* Length from tips of palpi to apex of genital papilla, 149μ; main body suture to apex of genital papilla, 81μ; greatest width of body, 118μ.

Female: Body elongate oval, broadest at mid-length. Apodemes distinct and clearly defined, those of legs I as long as genu I, extending in posteromedial directions from innermost angles of coxae I, converging medially at anterior extremity of median apodeme. Apodemes II one and one-half times as long as apodemes I, subparallel to latter, extending from anteromedial condyles of coxae II to points half length of apodeme from median apodeme at point midway between anterior extremity of the latter and transverse apodeme. Transverse apodeme transecting body at main body suture, its medial portion with anteriorly directed indentation, the truncate anterior margin of indentation as long as genu I. Anterior median apodeme conspicuous from V-shaped juncture of apodemes I to point in line with posteromedial extremities of apodemes II, continuing caudad from this point as a faint line to juncture with forward projection of transverse apodeme. Apodemes III as long as apodemes II, extending in anteromedial directions from forward extremities of coxae III, their posterolateral extremities thickened, anterior fifths curved at nearly right angles toward posterior, these extremities situated the length of genu I laterad from tips of anterior forks of median apodeme. Apodemes IV subequal in length to apodemes III, extending in anteromedial directions from points one half length of genu I mesad from inner margins of coxae III at their posterior thirds to intersection with median apodeme at point in line with anterior extremities of coxae III, the apodemes with a slight thickening at caudal extremities and at mid-lengths and becoming indistinct a short distance before intersection with median apodeme. Posterior median apodeme extending from point in line with caudal extremities of coxae III to point nearly in line with anterior extremities of these coxae, bifurcate at this point, each fork extending anterolaterally a distance equal to basal width of tarsus II, terminating the length of tibia III behind transverse apodeme. Hysterosomal sutures indistinct, one transecting body two thirds the distance from main body suture to anterior extremity of posterior median apodeme, one transecting body at posterior extremities of coxae III, one at anterior half of opisthosoma, one at posterior fourth of opisthosoma. Pseudostigmatic organs three fourths as long as tarsus II, expanded apex subcircular with diameter equal to one half length of organ, pedicel short, slender, basal ring with diameter equal to two thirds diameter of enlarged apex. Stigmatal openings indistinct, located immediately mesad from second pair of dorsal propodosomal setae; tracheae extending in medial direction from openings, forming two U-shaped, thickened, tubular pouches which occupy area near juncture of apodemes II with median apodeme, tracheae indistinct posterior to these thickenings. Dorsum of propodosoma extended anteriorly forming a sharply pointed cephalothoracic shield the forward extremity of which is located one half length of tarsus II anterior to first pair of dorsal propodosomal setae, shield projecting over three fourths of capitulum. *Dorsal chaetotaxy:* Propodosoma with two pairs of dorsal setae; first pair as long as leg I, situated the length of tarsus III behind and laterad from anterior extremity of propodosoma, separated from each other by a distance equal to one half greatest width of capitulum; setae of second pair more than twice as long as setae of first pair, situated a distance slightly greater than the length of tarsus III behind and laterad from setae of first pair. Hysterosoma with six pairs of dorsal setae; those of first pair as long as tibiotarsus I, situated on lateral margins of body one half length of seta behind main body suture; second pair of setae with length subequal to first pair, located one and one-third times length of seta from lateral margins of body, slightly behind setae of first pair; third pair of setae one half as long as first pair, situated twice length of seta from lateral margins of body, one half length of seta anterior to penultimate hysterosomal suture, separated from each other by a distance equal to five times length of seta; fourth pair of setae subequal in length to setae of first pair, located on lateral margins of body, one half length of seta posterior to penultimate hysterosomal suture; fifth pair of setae subequal in length to setae of fourth pair, located one third length of seta anterior to last hysterosomal suture, separated from each other by a distance equal to length of seta; sixth pair of dorsal hysterosomal setae slightly smaller than setae of fourth pair, situated on caudolateral margins of body, separated from each other by a distance equal to one and one-third times length of seta. *Ventral chaetotaxy:* Propodosoma with two pairs of ventral setae; first pair with length equal to one half length of genu I, located one half length of seta behind apodemes I at their anterior thirds; second pair of setae twice as long as first pair, situated slightly behind apodemes II at anterolateral fourths. Hysterosoma with three pairs of ventral setae; first pair as long as genu I, located the length of seta anterior to and slightly medial from most forward extremities of apodemes III, this being one and one-half times length of seta behind first hysterosomal suture, setae separated from each other by a distance equal to three times length of seta; second pair of setae one and one-half times as long as setae of first pair, located on apodemes IV near their posterolateral extremities; setae of third pair slightly longer than setae of second pair, located near lateral margins of apical segment of hysterosoma, separated from each other by a distance equal to three times length of seta. *Capitulum:* Length including palpi, 40μ; width, 35μ; subcordate, with posterior margin rounded truncate. Dorsal setae as long as genu I, located on lateral margins at apical sixth of capsule, separated from each other by a distance equal to length of seta. Ventral setae slightly shorter than dorsal setae, located near outer basal margins of palpi, separated from each other by a distance equal to twice length of seta. Palpi short, broad at base, curving inward toward broadly rounded apex, indistinctly segmented, length equal to length of genu I, one half as broad at base as long; subterminal bristles with length equal to one half basal width of appendage. Chelicerae short, styliform, projecting forward to tips of palpi; cheliceral sheaths with minute punctures. *Legs:* Anterior pairs of moderate length, first pair slightly longer than second pair. Leg I with coxa subquadrangular, about one and one-half times as broad as long, width equal to one half greatest width of capitulum, without vestiture; femur having length equal to width of coxa, nearly as broad as long, tapering slightly toward apex, with three setae; genu about one half as long as femur, slightly broader at base than long, tapering toward apex, with four setae; tibiotarsus slenger, elongate, about as long as combined lengths of femur and genu, slightly more than one fourth as broad as long, with one spinelike seta having length equal to one half basal width of segment located dorsally near outer margin the length of seta from base, one clavate, annulated seta with length equal to one third basal width of segment located dorsally near outer margin at apical third and ten normal setae; tarsus surmounted by a short pretarsus, its length equal to one half basal width of tarsus, bearing at its apex a large, broad, subcircular empodium beyond which projects a strong, curved claw. Leg II with coxa subquadrangular, one and one-third times as broad as long, without setae; femur as long as femur I, one and one-third times as long as broad at base, tapering toward apex, with three setae; genu one third as long as femur, one and one-half times as broad as long, tapering slightly toward apex, with three setae; tibia one and one-fourth times as long as genu, slightly longer than broad, lateral margins subparallel, with four setae; tarsus about twice as long as tibia, three times as long as broad at base, tapering to broadly rounded apex, with one short, oval, annulated seta having length equal to one half basal width of segment situated dorsally near inner margin slightly proximad from mid-segment, one short, rodlike seta with length equal to one half basal width of segment located mid-ventrally at apex, five normal setae; tarsus surmounted by a short pretarsus, its length equal to one half basal width of tarsus, bearing at its apex two large, spreading, curved claws between and beyond which projects a broad, subcircular empodium. Leg III with coxa elongate, broad, length equal to combined lengths of tibia and tarsus II, nearly one half as broad as long, without vestiture; femur as long as coxa, lateral margins slightly divergent from basal third toward apex, proximal portion of segment expanded, segment with four setae; tibia as long as femur, two and one-fourth times as long as broad at base, tapering slightly toward apex, with four setae; tarsus broad, elongate, two thirds as long as tibia, nearly four times as long as broad at base, lateral margins subparallel, with four setae; tarsus surmounted by short, broad, tapering pretarsus, bearing at its narrow apex two large, curved, spreading claws between and beyond which projects a broad, subcircular empodium. Leg IV with small, subtriangular coxa, about one and one-half times as broad as long, without vestiture; trochanter collarlike, nearly twice as broad as long, without setae; third segment narrow, elongate, nearly as long as combined lengths of tibia and tarsus III, about five times as long as broad at base, lateral margins tapering very slightly toward apex, with one ventral seta one fourth as long as segment located on outer margin two thirds length of seta from base of segment, one stout, lanceolate seta nearly one half as long as segment situated ventrally near outer margin the apical width of segment before apex; fourth segment one third as long as third segment, lateral margins subparallel to apical third, outer margin converging on inner margin distad from this point, with one stout, lanceolate seta one and two-thirds times as long as segment located ventrally near outer margin at about mid-segment, terminal seta about as long as leg IV. *Measurements:* Length from tips of palpi to apex of hysterosoma, 280μ; anterior extremity of propodosoma to apex of hysterosoma, 270μ; tip of propodosoma to main body suture, 59μ; width of body at main body suture, 114μ; width at anterior extremities of coxae III, 188μ; distance between anterior extremities of coxae III, 61μ.

Holotype: Male, Ft. Pierce, Fla., Sept. 10, 1947, M. R. Osburn, on orange leaves.

Allotype: Female, Ft. Pierce, Fla., Sept. 12, 1945, Osburn and Stahler, orange leaves.

Paratypes: One male and one female (plesiotypes), same data as allotype; two females (plesiotypes), same data as holotype (both specimens on same slide, which also contains one male); three males and three females, same data as allotype; one male, same data as holotype; two females, Ft. Pierce, Fla., Feb. 12, 1947, orange leaves, M. R. Osburn.

Location of types: Holotype, allotype and plesiotypes in Snow Entomological Museum, University of Kansas. Remaining paratypes at United States National Museum, Washington, D. C.

Additional specimens identified as this species are accompanied with the following data: Hummock Grove (Crosby), Citra, Fla., Oct. 17, 1951, M. H. Muma (two males and one female); Bamboo-Leesburg, Fla., Nov. 22, 1951, M. H. Muma, under orange leaves (two males and four females); Orange Co., Fla., Dec. 29, 1951, N. A. Walker, orange (two males and seven females); Deland, Volusia Co., Fla., Dec. 29, 1951, N. A. Walker, on orange leaves (six males and four females).

Males of this species are rather easily distinguished from males of the two other species in the genus by the absence of a spurlike projection of the inner margin of femur IV. The reduced claw of leg IV of this sex seems to indicate a closer affinity with *H. latus,* although the strong claws of legs III in the female are more like the female of *H. tepidariorum* than *H. latus.*

Correspondence with M. R. Osburn, who collected the type material, has brought to light the following information. Living specimens have the anterior part of the body colored jet black. They appeared to be numerous on orange trees only during certain periods of the year. No damage to the host plant was noticeable, and from this observation Osburn concluded that the mites were probably predaceous. Specimens collected by Walker were reported to be amber-colored in life.

Hemitarsonemus tepidariorum (Warburton)

(Plates 16, 21 and 25)

Tarsonemus tepidariorum Warburton, 1904, Jour. Roy. Agr. Soc. England, vol. 65, p. 285; Moznette, 1917, Jour. Agr. Res., vol. 10, no. 8, p. 373; Cameron, 1925, Ann. Appl. Biol., vol. 12, no. 1, p. 93.

Hemitarsonemus tepidariorum (Warburton), Ewing, 1939, U. S. Dept. Agr. Tech. Bul. 653, p. 52; Pritchard, 1951, California Agr., vol. 5, no. 7, p. 10.

Male: Body short, oval, broadest at anterior condyles of coxae III. Legs long, spindly, anterior pairs subequal in size. Apodemes conspicuous and well-defined; those of legs I as long as genu I, extending posteromedially from anterior basal angles of coxae I to juncture with anterior extremity of median apodeme. Apodemes II subparallel to apodemes I extending from anterior basal condyles of coxae II almost to median apodeme. Anterior median apodeme well-defined from anterior extremity to point in line with median extremities of apodemes II, becoming less distinct from this point to its posterior extremity at main body suture. Apodemes III extending from anterior condyles of coxae III in anteromedially directed arcs intersecting apodemes IV and median apodeme slightly behind main body suture. Apodemes IV straight, extending from outer basal condyles of coxae IV in anteromedial directions to juncture with apodemes III. Posterior median apodeme distinct for its entire length, extending from point in line with anterior margins of coxae IV to point the length of genu I behind main body suture, two forks branching from median apodeme just before its posterior extremity and extending to inner basal angles of coxae IV. *Dorsal chaetotaxy:* Propodosoma with four pairs of dorsal setae; those of anterior pair as long as capitulum, situated one third length of seta behind anterior margin of cephalothoracic shield, separated from each other by a distance equal to half length of seta. Second pair of setae minute, less than one fourth as long as setae of first pair, situated two thirds length of capitulum behind and slightly laterad from setae of first pair. Third pair of setae three times as long as setae of first pair, situated behind and slightly laterad from second setae a distance slightly less than distance between first and second setae. Fourth pair of setae slightly shorter than setae of first pair, located one half length of seta laterad from setae of third pair and slightly behind third setae. Hysterosoma with four pairs of dorsal setae; those of first pair three fourths as long as first propodosomals and not as stout, located near lateral margins of body one half length of seta behind main body suture. Second and third pairs of dorsal hysterosomal setae subequal in length, nearly twice as long as first propodosomals. Fourth pair of setae as long as first propodosomals, located near hind margin of body at apical third of genital papilla. *Ventral chaetotaxy:* First ventral propodosomal setae small, length equal to width of genu I, located the length of seta laterad from Y-shaped juncture of apodemes I and median apodeme. Second pair of setae one and one-half times as long as setae of first pair, situated near centers of areas delimited by apodemes II and main body suture. First ventral hysterosomal setae as long as second ventral propodosomals, located slightly mesad from apodemes III at their anterior thirds. Second ventral hysterosomal setae slightly longer than setae of first pair, located one third length of seta laterad from posterior thirds of apodemes IV. *Capitulum:* Slender, subcordate, with posterior margin rounded truncate. Length including projecting palpi, 33μ; greatest width, 23μ. Dorsal setae with length equal to one third length of capitulum, located on lateral margins at apical third. Ventral setae slightly shorter than dorsal setae, situated at apical third of capitulum. Palpi short, stout, indistinctly segmented, tuberculate apically. Chelicerae short; cheliceral sheaths not striated. *Legs:* Leg I with coxa subquadrangular, as broad as long, without setae; femur twice as long as broad, sides subparallel, with three setae; genu nearly as broad as long, with four setae; tibia slightly longer than genu, with one slender, rodlike, annulated seta nearly as long as basal width of segment, located middorsally at basal fifth, one stout, spinelike seta as long as annulated seta located dorsally near outer margin at basal fourth, five normal setae; tarsus slightly longer than tibia tapering to bluntly rounded apex, with one short, rodlike, annulated seta as long as basal width of segment located dorsally at basal fourth, seven normal setae; tarsus surmounted by a short, narrow pretarsus bearing at its apex a stout, curved claw and a broad empodium. Leg II with coxa and femur similar in size and chaetotaxy to these segments in leg I; genu as broad as long, with three setae; tibia one and one-third times as long as broad, with four setae; tarsus slender, elongate, tapering from base to bluntly rounded apex, with one broad, annulated seta nearly as long as basal width of segment, located dorsally near outer margin at basal fifth, four normal setae; tarsus surmounted by a short, narrow pretarsus bearing at its apex two curved, spreading claws and a broad, bilobed empodium. Leg III with coxa twice as long as broad, length equal to combined lengths of tibia and tarsus II, without vestiture; femur slender, elongate, as long as coxa, three times as long as broad, with one seta; genu slightly longer than broad, with three setae; tibia one and one-half times as long as genu, sides subparallel, with four setae; tarsus as long as tibia, tapering to narrowly rounded apex, with three setae; tarsus surmounted by a short pretarsus bearing two spreading, curved claws between and beyond which projects a broad, bilobed empodium. Leg IV with coxa narrow, subquadrangular, longer than broad, with one ventral seta; femur about twice as long as broad, basal two thirds of segment with broad inner margin terminating in a spur, segment narrow distad from spur, with two small and one stout setae; tibia slender, elongate, two thirds as long as femur, segment bowed inward at apical fourth, with one subapical, rodlike, annulated seta, one long, subapical, tactile seta; tarsus small, inconspicuous, broader than long, with three small setae; tarsus surmounted by a strong, slightly curved, slender, blunt claw, its length about equal to one half length of tibia. *Genital papilla:* Large and well defined; subcordate with posterior margin truncate; length 37μ; width 38μ. *Measurements:* Length from tips of palpi to apex of genital papilla, 170μ; anterior margin of cephalothoracic shield to main body suture, 59μ; main body suture to hind extremity of genital papilla, 87μ; width of body at anterior extremities of coxae III, 110μ.

Female: Body broad, oval, broadest at anterior condyles of coxae III. Apodemes conspicuous and well-defined, those of legs I as long as genu I, extending in posteromedial directions from inner condyles of coxae I, converging medially to form Y-shaped juncture with median apodeme; apodemes II subparallel to and twice as long as apodemes I, extending from anterior basal angles of coxae II almost to median apodeme; anterior median apodeme strong and distinct, extending from juncture of apodemes I almost to main body suture, its posterior extremity a short distance behind converging extremities of apodemes II; apodemes III short, curved, extending in arcs from anterior condyles of coxae III nearly to mid-body, distinct only in lateral halves of lengths; apodemes IV weak, straight, extending in anteromedial directions from anterior condyles of coxae IV a distance equal to length of tibiotarsus I, their anterior extremities separated from each other by a distance equal to length of apodeme; posterior median apodeme weak, indistinct, extending from point in line with anterior extremities of apodemes III to point in line with their posterior extremities. Hysterosomal segmentation indistinct except for a prominent suture transecting body just posterior to coxae IV! Pseudostigmatic organs slightly shorter than tarsus II, their expanded apices subcircular, with diameters equal to one half basal width of tibiotarsus I. Stigmatal openings pronounced, situated near dorsolateral margins of propodosoma just anterior to base of cephalothoracic hood, this narrow hood joining broad portion of propodosoma at point in line with bases of pseudostigmatic organs. Conspicuous, circular tracheal pouches present in medial position between stigmatal openings. *Dorsal chaetotaxy:* First pair of propodosomal setae quite strong, with length equal to width of capitulum, located just behind anterolateral angles of cephalothoracic shield nearly the length of seta anterior to stigmatal openings. Second pair of propodosomal setae twice as long and not as stout as setae of first pair, located on dorsolateral margins of body midway between stigmatal openings and main body suture. First pair of dorsal hysterosomal setae with length equal to length of tibia II, located near lateral margins of body the length of seta behind main body suture. Second dorsal hysterosomal setae like setae of first pair, situated slightly more than length of seta behind main body suture midway between lateral margins of body and mid-body. Third pair of setae slightly shorter than second pair, located twice length of seta anterior to hysterosomal suture, three times length of seta from mid-body. Fourth pair of setae stout, as long as first pair, located near apex of hysterosoma, setae separated from each other by a distance equal to three times length of seta. *Ventral chaetotaxy:* First pair of propodosomal setae nearly as long as genu I, located the length of seta laterad from anterior extremity of median apodeme. Setae of second pair one and one-half times as long as first setae, located on apodemes II at their lateral thirds. First hysterosomal setae as long as first propodosomals, located at anterior extremities of apodemes III, setae separated from each other by a distance equal to twice length of seta. Second ventral hysterosomal setae as long as setae of first pair located in line with apodemes IV at their mid-lengths. Remaining pair of ventral hysterosomal setae short, situated normally at apex of opisthosoma. *Capitulum:* Narrow, subcordate; length including palpi, 36μ; greatest width, 26μ. Dorsal setae with length equal to one third length of capitulum, located on dorsolateral margins of capsule at anterior third. Ventral setae as long as dorsal setae, situated near bases of palpi slightly behind dorsal setae. Palpi short, robust, indistinctly segmented, projecting slightly beyond apex of capitulum. Chelicerae normal; cheliceral sheaths not striated. *Legs:* Anterior pairs rather short and stubby, first pair slightly more robust than second pair, noticeable especially in the broad tibiotarsus I compared to the slender tarsus II. Leg I with coxa subquadrangular, broader than long, without setae; femur three fourths as broad as long, inner margin one half as long as outer margin, segment with two normal setae and one broad, lanceolate, dorsal seta situated at about mid-segment; genu slightly broader than long, with four setae; tibiotarsus robust, slightly more than twice as long as broad at base, tapering gently to broadly rounded apex, segment with one slender, annulated seta with length equal to one half basal width of segment located dorsally near outer margin at apical two fifths, fourteen normal setae, a broad, ventral spurlike, transverse projection just before apex of segment extending from ventral surface; tibiotarsus surmounted by a short, broad pretarsus bearing at its apex a broad, circular empodium and a short, stout, curved claw.

Leg II with coxa subquadrangular, slightly broader than long, without vestiture; femur similar in size and shape to femur I, with three normal setae; genu slightly broader than long, with three setae; tibia slightly longer than broad, with four setae; tarsus twice as long as broad at base, tapering to narrowly rounded apex, with four normal setae, one clavate, annulated seta with length equal to two thirds basal width of segment, located dorsally near inner margin at basal fifth of segment, one small ventral spur projecting from inner apical margin of segment; tarsus surmounted by a short pretarsus bearing at its apex two strong, curved, spreading claws between and beyond which projects a broad empodium. Leg III with coxa slender, elongate, as long as combined lengths of femur and genu I, one third as broad as long, without vestiture; femur three fourths as long as coxa, basal third expanded, bulbous, partially separated from apical portion of segment by a constriction and incomplete suture, distal two thirds of segment with sides diverging slightly toward apex, three setae all situated on telofemur; tibia slender, elongate, nearly as long as femur, with four setae all situated on apical half of segment; tarsus slender, elongate, two thirds as long as tibia, tapering to narrowly rounded apex, with three setae and a short, ventral, terminal spur; tarsus surmounted by a short pretarsus bearing at its apex two strong, curved, spreading claws between and beyond which projects a broad empodium. Leg IV with coxa subtriangular, as broad as long, without vestiture; trochanter short, collarlike, without setae; third segment slender, elongate, sides converging from base to mid-segment, subparallel distad from this point, proximal seta weak, one third as long as segment, situated ventrally near outer margin at basal fourth of segment, distal seta strong, two thirds as long as segment, situated ventrally near outer margin at apical fourth; fourth segment two thirds as long as third segment, proximal seta similar to distal seta of third segment, located ventrally at apical two fifths, terminal seta short, its length slightly exceeding length of terminal segment. *Measurements:* Anterior margin of propodosoma to apex of hysterosoma, 243μ; tip of propodosoma to main body suture 78μ; width of body at anterior condyles of coxae III, 156μ; distance between anterior condyles of coxae III, 70μ.

Types: England, Sept. 1903, on fern plants in greenhouse.

Location of types: Possibly at Zoological Laboratory, Cambridge, England.

This mite species is commonly known as the fern mite because of the serious damage inflicted upon ferns of various species. Originally described from specimens found damaging greenhouse ferns in England in 1904, it has subsequently been recorded from greenhouse ferns in Minnesota and California. An excellent account of its biology is given by Cameron (1924) and some biological information worthy of note has been published by Pritchard (1951).

Recorded hosts of this mite include several species of *Pteris*, *Asplenium bulbiferum* and *Polystichum* sp. Typical damage usually includes leaf deformities and stunting of plants very similar to the type damage inflicted by *H. latus* and *S. pallidus*.

Specimens examined by the present writer are identified with the following data: University of Minnesota, April 17, 1929, holly fern; Plath Nursery, San Francisco, California, March 15, 1951, A. E. Pritchard, on *Pteris* sp.

Genus *Xenotarsonemus*, new genus

This genus is characterized in the males by having leg IV with three segments, coxa, femur and tibiotarsus, the latter expanded bulbously at tip, bearing a stout, curved spine on outer margin near base, one long, stout, apical seta and two short, apical setae; femur with inner margin produced into a small spurlike process; tibiotarsus I with a long, broad seta more than one half as long as segment, located near outer margin at base. Females with cephalothoracic shield projecting forward and covering most of capitulum; legs IV never extending to caudolateral margins of body; inner margins of coxae IV separated by a distance less than width of coxa.

Type of genus.—*Tarsonemus viridis* Ewing.

This genus is here proposed to include the single species designated as genotype. *T. viridis*, at the time of its original description by Ewing (1939), was recognized by him to be distinctive enough to suggest possible removal to a new genus. As indicated earlier in this paper, the present writer feels that in this species is found the culmination of specialization in the family Tarsonemidae as presently constituted.

Xenotarsonemus viridis (Ewing), new combination

(Plates 14, 21 and 25)

Tarsonemus viridis Ewing, 1939, U. S. Dept. Agr. Tech. Bull., 653, p. 35.

Male: Body broadly oval, broadest just behind main body suture; legs rather long and stout, the anterior pair conspicuously longer than legs II; apodemes moderately strong and well-defined; genital papilla of medium size, smaller than capitulum. Apodemes I slightly longer than genu I, extending in posteromedial directions from anterior basal angles of coxae I, converging medially to form a Y-shaped juncture with anterior extremity of median apodeme. Apodemes II about twice as long as apodemes I and subparallel to the latter, extending from innermost angles of coxae II to juncture with median apodeme. Transverse apodeme apparently absent. Anterior median apodeme strong and conspicuous from its anterior extremity at juncture of apodemes I to point slightly caudad from juncture of apodemes II, becoming less distinct from here to main body suture. Apodemes III slightly longer than apodemes I, extending in anteromedial directions from anterior condyles of coxae III, terminating indistinctly at points the length of genu I behind main body suture. Apodemes IV about twice as long as apodemes III and subparallel to the latter, extending from outer basal angles of coxae IV to points the length of tibia I behind main body suture. Posterior median apodeme extending from point in transverse alignment with anterior extremities of apodemes IV to point just anterior to bases of coxae IV, bifurcating here with each arm continuing to inner basal angle of coxa IV. A conspicuous hysterosomal suture transects body dorsally at anterior two fifths of genital papilla. Dorsal propodosomal plate extended forward to form a broad cephalothoracic hood which covers basal third of capitulum, the truncate anterior margin of hood with dimension slightly exceeding greatest width of capitulum. *Dorsal chaetotaxy:* First pair of dorsal propodosomal setae with length equal to two thirds greatest width of capitulum, situated at anterolateral extremities of cephalothoracic hood and separated from each other by a distance equal to one and one-fourth times length of seta; second dorsal propodosomals two thirds as long as setae of first pair, situated behind first setae a distance equal to length of first seta; third pair of setae one and one-fourth times as long as setae of first pair, situated behind and slightly laterad from second setae a distance equal to one half the distance separating first and second setae; fourth dorsal propodosomals slightly longer than first setae, located behind and slightly laterad from third setae a distance about equal to that separating second and third setae. First pair of dorsal hysterosomal setae as long as first dorsal propodosomals, situated near lateral margins of body two thirds length of seta behind main body suture; second dorsal hysterosomals as long as fourth propodosomals; third pair of setae one and one-half times as long as setae of second pair and situated near lateral margins of genital papilla at anterior fourth of papilla, the setae separated from each other by a distance equal to one half length of setae; fourth dorsal hysterosomals as long as second dorsal propodosomals, located on lateral margins of genital papilla at about the posterior two fifths of papilla. *Ventral chaetotaxy:* First pair of ventral propodosomal setae slightly shorter than length of genu I, located one half length of seta from median apodeme, this distance behind anterior extremity of apodeme; second ventral propodosomals one and one-half times as long as setae of first pair, located near centers of areas delimited by median apodeme, main body suture and bases of coxae II. First pair of ventral hysterosomal setae as long as second ventral propodosomals, situated the length of seta mesad from anterior extremities of apodemes III, this distance behind main body suture; second ventral hysterosomals one and one-third times as long as setae of first pair, located on apodemes IV at about mid-lengths of apodemes. *Capitulum:* Broadly subcordate, with posterior margin rounded truncate; length, including projecting palpi, 30μ; greatest width, measured at posterior third, 24μ. Dorsal setae with length equal to width of genu I, situated near anterolateral extremities of capsule; ventral setae two thirds as long as dorsal setae, located near bases of palpi and separated from each other by a distance equal to one and one-third times length of seta. Palpi short and stout, projecting a short distance beyond apex of capsule, indistinctly segmented and ornamented. Chelicerae short and styliform, projecting between and slightly beyond apices of palpi; cheliceral sheaths without transverse striations. *Legs:* Leg I with coxa slightly longer than broad at base, tapering from base to apex, without setae; femur two and one-half times as long as broad at base, with three stout setae and one short bristle; genu broader than long, with three setae; tibia twice as long as broad at base, tapering slightly from base to apex, with one sensory peg nearly as long as basal width of segment, located on outer margin at basal fourth, one short, clavate seta with length equal to one third basal width of segment located ventrally on outer margin at basal fourth, six normal setae; tarsus narrow, elongate, as long as combined lengths of tibia and tarsus II, tapering from base to broadly rounded apex, with one long, broad, blunt seta two thirds as long as segment, situated dorsally near outer margin at base of segment, seven normal setae; tarsus surmounted by a slender pretarsus bearing a conspicuous, subcircular empodium with diameter slightly less than apical width of tarsus, beyond which projects a single, curved claw. Leg II with coxa subquadrangular, slightly longer than broad, without setae; femur twice as long as broad, lateral margins convex, segment with three setae; genu broader than long, with three setae; tibia slightly longer than broad, outer margins convex, with four setae; tarsus narrow, elongate, more than four times as long as broad at base, slightly longer than combined lengths of genu and tibia, with one broad, blunt, curved seta nearly as long as segment located dorsally near outer margin at base of segment the seta inserted on a short tubercle, four normal setae; tarsus surmounted by a short, narrow pretarsus bearing terminally two strong, curved, spreading claws between which projects a broad empodium. Leg III with coxa two and one-half times as long as greatest breadth, its length almost equal to combined lengths of three apical segments of leg III, without vestiture; basifemur subglobose, as broad as long, without setae; telofemur twice as long as broad, with two setae; genu slightly broader than long, with three setae; tibia nearly twice as long as broad, lateral margins subparallel, with four setae; tarsus narrow, elongate, tapering from base to narrowly rounded apex, with three setae; tarsus surmounted by two curved, spreading claws between and beyond which projects a broad, bilobed empodium. Leg IV with coxa subquadrangular, slightly broader than long, with one ventral seta as long as segment; femur about three times as long as greatest breadth, with one seta one half as long as segment located dorsally near outer margin at apical fourth of segment, one short, stout, pointed, peglike seta located ventrally on inner margin at basal third of segment the seta inserted on a tuberclelike swelling, one strong seta nearly as long as segment located ventrally on inner margin at apical fourth, segment with a spurlike projection on inner margin at apical fourth; tibiotarsus two thirds as long as femur, constricted medially, broad at base, bulbous apex with one long, broad, curved seta longer than segment located dorsally on outer margin at basal fifth of segment, one broad, dorsal, pointed, peglike bristle located near inner margin at apex, one seta two thirds as long as segment located ventrally near inner margin the width of segment before apex, one long, stout seta twice as long as segment situated mid-ventrally just before apex. *Genital papilla:* Subcordate, with anterior margin rounded truncate and having a slight mesal emargination; length, 19μ; greatest width, measured at anterior fourth, 20μ. *Anal plate:* Small and weakly sclerotized, its triradiate apodemal arms each with length equal to basal width of tarsus III, the central disc situated ventrally one half length of genital papilla anterior to anterior margin of the latter. *Measurements:* Length, from tips of palpi to apex of genital papilla, 136μ; anterior margin of cephalothoracic hood to apex of genital papilla, 122μ; anterior margin of hood to main body suture, 50μ; width of body at main body suture, 75μ; width at anterior condyles of coxae III, 85μ.

Female: Body broadly oval, broadest at mid-length; anterior pairs of legs short and stout, legs IV short and robust, their terminal segments not extending to body margins. Anterior apodemes indistinct, those of legs I extending in posteromedial directions from innermost angles of coxae I, converging medially to form a Y-shaped juncture with anterior extremity of median apodeme. Apodemes II extending from innermost angles of coxae II toward mid-point of main body suture, terminating indistinctly at points about two thirds this distance. Transverse apodeme apparently absent. Anterior median apodeme extending from juncture of apodemes I to main body suture, weak and rather indistinct for posterior half of its length. Apodemes III as long as width of coxa III, extending in anteromedial directions from anterior condyles of coxae III, their mesal extremities indistinct. Apodemes IV subparallel to one another for most of their lengths, extending anteriorly from outer basal angles of coxae IV one half the distance to main body suture. Posterior median apodeme indistinct, extending from bases of coxae IV two fifths the distance to main body suture. Dorsum of propodosoma projected anteriorly to form a cephalothoracic hood with a broadly rounded anterior margin, the hood covering basal three fourths of capitulum. Pseudostigmatic organs with expanded, ovate apices slightly longer than the narrow pedicels; areoli with diameters nearly equal to width of expanded apices. Tracheal openings large and conspicuous, situated dorsolaterally at base of cephalothoracic hood. *Dorsal chaetotaxy:* First pair of dorsal propodosomal setae with length equal to about one half the distance between tracheal openings, situated just anterior and medial to caudolateral extremities of cephalothoracic hood; second pair of dorsal propodosomal setae about twice as long as first pair, located just above and slightly behind areoli of pseudostigmatic organs. First pair of dorsal hysterosomal setae with length equal to length of tibiotarsus I, located on lateral margins of body one fourth length of seta behind main body suture; second pair of setae two thirds as long as first pair, located one and one-half times length of seta from lateral margins of body at points in line with anterior thirds of coxae III; third pair of setae with length subequal to second pair, situated one and one-half times length of seta from lateral margins of body, slightly behind and laterad to trochanters IV; fourth pair of dorsal hysterosomal setae with length equal to width of femur III, located on lateral margins of body at mid-opisthosoma; fifth pair of setae twice as long as fourth pair, located one third length of seta from hind margin of penultimate segment, separated from each other at their bases by a distance equal to three fourths length of seta, when extending directly caudad their tips projecting slightly beyond apex of body; sixth pair of dorsal hysterosomal setae having length subequal to fifth pair, situated near lateral margins of body at basal third of apical segment. *Ventral chaetotaxy:* First pair of ventral propodosomal setae with length equal to basal width of tibiotarsus I, located slightly more than length of seta laterad from Y-shaped juncture of apodemes I and anterior median apodeme; second pair slightly longer than first pair, situated slightly behind apodemes II at their mid-lengths. First pair of ventral hysterosomal setae with length equal to width of coxa III, located one fourth length of seta behind main body suture and separated from each other by a distance equal to twice length of seta; second pair of ventral hysterosomal setae as long as first pair, located between inner margins of coxae III and apodemes IV, in line with mid-lengths of coxae III; third ventral hysterosomals minute, located at apex of opisthosoma. *Capitulum:* Length, 32μ; width, 35μ; subcordate with posterior margin rounded truncate, anterior margin broadly rounded with palpi and chelicerae projecting slightly. Dorsal setae with length equal to one fourth greatest breadth of capitulum, inserted on lateral margins of capsule in line with bases of palpi. Ventral setae two thirds as long as dorsal setae, separated from each other by a distance equal to one and one-half times length of seta. Palpi indistinctly ornamented and segmented. Chelicerae normal; cheliceral sheaths without striae. *Legs:* Leg I with coxa subquadrangular, as broad as long, without setae; femur nearly as broad at base as long, basal half of segment bulbous, lateral margins strongly convex, segment with three setae; genu as broad at base as long, lateral margins converging abruptly at apical third of segment, with four normal setae; tibiotarsus robust, about four times as long as broad at base, tapering very little from base to apex, vestiture dense, consisting of one lanceolate seta slightly longer than basal width of segment located dorsally on outer margin at basal third, one ventral, lanceolate seta with length equal to one half basal width of segment located on outer margin the length of seta from base of segment, one short, pointed bristle having length equal to two thirds basal width of segment, located ventrally near outer margin the length of seta from base, eleven normal setae; blunt apex of tibiotarsus surmounted immediately by a strong, curved claw and a small empodium. Leg II similar in size and general shape to leg I, with coxa subquadrangular, nearly one and one-half times as broad as long, without setae; femur about one and one-half times as long as broad at base, proximal two thirds of segment greatly expanded, bulbous, segment with three setae; genu about as broad as long, inner margin abruptly convergent at apical fourth of segment, with four setae; tibia one and one-half times as long as broad, slightly broader at apex than at base, with one peglike seta having length equal to basal width of segment, located dorsally near outer margin at base, with one broad, stout, lanceolate spine four times as long as broad at base, its length equal to basal width of segment, situated ventrolaterally on wartlike expansion of outer margin at apex of segment, two normal setae; tarsus slightly longer than broad at base, tapering to narrowly rounded apex, segment with a single seta one and one-half times length of tarsus located middorsally near outer margin; tarsus subtends a pair of strong, spreading, curved claws and a reduced empodium, the terminal appendages borne on a short pretarsal segment. Leg III rather short and robust; coxa broad, oval, about twice as long as greatest breadth, inner and outer margins convex, segment without vestiture; femur about three times as long as broad, expanding slightly from basal third to apex, with four setae; tibia one and one-half times as long as broad at base, tapering slightly to apex, with three setae; tarsus narrow, elongate, about five times as long as broad at base, tapering slightly to bluntly rounded apex, with four normal setae; tarsus surmounted by a narrow pretarsus, as long as basal width of tarsus and bearing apically a pair of large, spreading, curved claws between which projects a broad empodium. Leg IV with coxa small, subquadrangular, nearly one and one-half times as broad as long, its inner margin separated from this margin of opposite coxa by a distance slightly less than width of coxa, segment without seta; trochanter collarlike, twice as broad as long, without vestiture; third segment slightly more than four times as long as broad at base, lateral margins subparallel, with one ventrolateral seta having length equal to twice width of segment, situated near outer margin one third length of seta from base of segment, one ventrolateral seta two thirds as long as segment, located near inner margin one third length of seta from apex of segment; fourth segment one third as long as third segment, about twice as long as broad at base, with one stout, ventral seta as long as combined lengths of third and fourth segments of leg IV, situated one half width of segment before apex, one terminal seta on segment, slightly longer than subterminal seta but not as broad as the latter basally. *Measurements:* Length from tip of cephalothoracic hood to apex of opisthosoma, 173μ; anterior margin of cephalothoracic hood to main body suture, 75μ; width of body at main body suture, 105μ.

Types: Belle, Maryland, Oct. 16, 1933, F. F. Smith, on *Fragaria* sp.

Location of types: United States National Museum, slide number 1129.

The writer had two specimens of this species available for study. These were of each sex and contained the following data: Belle, Maryland, Oct. 16, 1933, strawberry, F. F. Smith. These specimens undoubtedly represent some of the type material from which Ewing derived his original description although the slides were not identified by the type number. The cotype series, including males and females, remounted one mite per slide from the single original slide, make it possible at this time to designate as lectotype one of the male specimens which is identified by U.S.N.M. No. 1129-A.

These mites are an apple green in color and the male is quite distinctive, being readily distinguished from other tarsonemid species by characters mentioned in the preceding keys. The female, on the other hand, lacks an obvious character for differentiation from other species of tarsonemids and hence details of tibiotarsus I chaetotaxy must be relied upon for identification.

ADDENDUM

Due to the fact that to date keys to the females of mites in the family Tarsonemidae, where they exist, are not readily usable for reasons mentioned in an earlier section of this paper (External Morphology and Terminology), there follows below such a key to the species included in the present paper.

Key to Females of Western Hemisphere Tarsonemidae

1. Palpi greatly elongated, projecting forward to form a snoutlike beak . . . . *R. niger,* p. 1221
   Palpi not greatly elongate, never forming a conspicuous beak 2
2. Integument with conspicuous reticulations . . . . *T. truncatus,* p. 1220
   Integument without conspicuous reticulations 3
3. Hysterosoma with an extra pair of ventral setae situated between coxae IV . . . . *H. latus,* p. 1293
   Hysterosoma without a pair of ventral setae situated between coxae IV 4

4. Femur I with a stout lanceolate seta and two or three normal setae 5
Femur I without a stout seta 6
5. First ventral propodosomal seta located on or in front of apodeme I .... *T. randsi*, p. 1133
First ventral propodosomal seta located well behind apodeme I .... *S. pallidus*, p. 1267
6. Pseudostigmatic organs never with apices expanded, organs spinelike .... *T. dispar*, p. 1148
Pseudostigmatic organs with expanded apices subtended by slender pedicels 7
7. Pseudostigmatic organs with expanded apices acuminate distally, 8
Pseudostigmatic organs not acuminate distally 9
8. First pair of ventral propodosomal setae situated on or in front of apodemes I; hosts are bamboos and related plants, *S. phyllophorus*, p. 1244
First pair of ventral propodosomal setae situated well behind apodemes I; hosts are liliaceous and related plants *S. laticeps*, p. 1231
9. Terminal seta of leg IV short, only slightly longer than subterminal seta of fourth segment 10
Terminal seta of leg IV elongate, always much longer than subterminal seta of fourth segment 11
10. Pseudostigmatic organs with expanded apices elongate oval; femur I with normal setae only .... *X. viridis*, p. 1314
Pseudostigmatic organs with expanded apices subcircular; femur I with a stout, lanceolate seta and two normal setae, *H. tepidariorum*, p. 1308
11. First ventral propodosomal seta situated well behind apodeme I 12
First ventral propodosomal seta situated on or nearly on apodeme I 15
12. Genu II with a stout lanceolate or spinelike seta and two normal setae 13
Genu II with normal setae only 14
13. Second ventral hysterosomal setae situated on apodemes II; body slender, elongate, with anterior pairs of legs widely separated from posterior pairs; plant host, pineapple .... *S. ananas*, p. 1276
Second ventral hysterosomals located well behind apodemes II; body broadly oval .... *T. sulcatus*, p. 1155
14. Pseudostigmatic organs with expanded apices elongate oval; genu I with three setae .... *T. texanus*, p. 1196
Pseudostigmatic organs with expanded apices broadly oval; genu I with four setae .... *S. chionaspivorus*, p. 1285
15. Body elongate with anterior pairs of legs widely separated from posterior pairs; tracheal atria often prominent, elongate and bilobed 16
Body broadly oval; tracheal atria never bilobed 19
16. First ventral propodosomal setae situated in front of apodemes I .... *S. spirifex*, p. 1261
First ventral propodosomals located on or behind apodemes I 17
17. Small species, less than 150μ from anterior margin of cephalothoracic hood to apex of opisthosoma .... *S. latipes*, p. 1238

Large species, measuring more than 200μ from anterior margin of hood to apex of opisthosoma 18

18. Second ventral propodosomal setae situated well behind apodemes II; pseudostigmatic organs with expanded apices elongate oval; genu II with one lanceolate seta, one peglike seta and one normal seta *S. bancrofti*, p. 1249

Second ventral propodosomals situated nearly on apodemes II; pseudostigmatic organs with apices broadly oval; genu II with one stout, lanceolate seta and two normal setae . . *S. hyaleos*, p. 1256

19. Expanded apical portions of pseudostigmatic organs subcircular . 20

Expanded apical portions of pseudostigmatic organs oval 23

20. Anterior margin of cephalothoracic hood sharply rounded, nearly acuminate mesially *H. peregrinus*, p. 1300

Anterior margin of cephalothoracic hood truncate 21

21. First ventral propodosomal setae situated well behind apodemes I, *T. cryptocephalus*, p. 1162

First ventral propodosomal setae situated on or very nearly on apodemes I 22

22. Femur II with one stout, lanceolate seta and one or two normal setae; propodosoma with a conspicuous dorsal apodeme, *T. setifer*, p. 1125

Femur II with normal setae only; propodosoma without a dorsal apodeme . . . . . . *S. fulgens*, p. 1281

23. First ventral propodosomal setae located well behind apodemes I, 24

First ventral propodosomal setae located on or very nearly on apodemes I 25

24. Transverse apodeme with two conspicuous notches mesally, *T. confusus*, p. 1173

Transverse apodeme, if present, without two mesal notches, *T. smithi*, p. 1141

25. Genu II with normal setae only; transverse apodeme, if present, strong for its entire length 27

Genu II with one modified seta, either lanceolate or stout and spinelike; transverse apodeme strong for most of its length but weak or absent for a short distance mesally 29

26. Transverse apodeme apparently absent; tibiotarsus I with largest annulated, sensory seta located distinctly basad from mid-segment 28

Transverse apodeme strong and conspicuous for its entire length; tibiotarsus I with largest annulated, sensory seta situated at mid-segment . . . . *T. waitei*, p. 1181

27. Tibiotarsus I robust, two and one-half times as long as broad; leg I claw of moderate size . . . . . . *T. simplex*, p. 1188

Tibiotarsus I more than three times as long as broad at base; claw of leg I very small . . . . . . *T. pritchardi*, p. 1202

28. Tibiotarsus I with three specialized sensory setae near base of segment . . . . . . *T. scaurus*, p. 1213

Tibiotarsus I with a single specialized sensory seta near base of segment . . . . *T. occidentalis*, p. 1117

LIST OF SYNONYMS AND OTHER NAMES ENCOUNTERED IN THE LITERATURE OF THE FAMILY TARSONEMIDAE *

Acarus Linnaeus, 1856:
  translucens Nietner, 1861. (Probably Canestriniidae.)
  translucens Green (not Nietner, 1861), 1890 = *Hemitarsonemus latus* Banks.
  woodi Rennie, 1918 = *Acarapis woodi* (Rennie). (Tarsopolipodidae.)
Avrosia Oudemans, 1928. (? Canestriniidae; believed by some workers to be a senior synonym of *Hemitarsonemus* Ewing.)
Cheylurus socialis Trouessart, 1885 = *Tarsonemus floricolus* Canestrini and Fanzago.
Dendroptus robinii Kramer, 1876 = *Tarsonemus floricolus* C. and F. according to Oudemans (1926).
Hemitarsonemus Ewing, 1939:
  latus (Banks), 1904.
  peregrinus, new species in this paper.
  tepidariorum Warburton, 1904.
Microdispodides Vitzthum, 1914. (Scutacaridae.)
Pseudotarsonemoides Vitzthum, 1921. (Tarsopolipodidae.)
  cryptocephalus Ewing, 1939 = *Tarsonemus cryptocephalus* (Ewing). New synonymy in this paper.
Steneotarsonemus, new genus in this paper.
  ananas (Tryon), 1908.
  bancrofti (Michael), 1890.
  chionaspivorus (Ewing), 1911.
  fulgens, new species in this paper.
  hyaleos, new species in this paper.
  laticeps (Halbert), 1923.
  latipes (Ewing), 1939.
  pallidus (Banks), 1901.
  phyllophorus (Ewing), 1924.
  spirifex (Marchal), 1902.
Tarsolarkus Thor, 1904. (? Pyemotidae.)
Tarsonemella Hirst, 1923. (? Tarsopolipodidae.)
Tarsonemoides Trågardh, 1904. (? Scutacaridae.)
Tarsonemus Canestrini and Fanzago, 1876:
  africanus Hirst, 1923. (Probably Tarsopolipodidae.)
  apis Rennie, 1918. (Probably Tarsopolipodidae.)
  ananas Tryon, 1908 = *Steneotarsonemus ananas* (Tryon). New combination in this paper.
  approximatus Banks, 1914 = *Steneotarsonemus chionaspivorus* (Ewing). New combination in this paper.
  approximatus var. *narcissi* Ewing, 1929 = *Steneotarsonemus laticeps* (Halbert).
  assimilis Banks, 1914 = *confusus* Ewing.
  aurantii Oudemans, 1927.
  bakeri Ewing, 1939 = *setifer* Ewing.
  bancrofti Michael, 1890 = *Steneotarsonemus bancrofti* (Michael). New combination in this paper.

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* This is a list of names applied to mite species belonging to the family Tarsonemidae or confused with mites of this family.

biungulatus Ewing, 1939 = *smithi* Ewing.
brevipes Sicher and Leonardi, 1895.
buxi Canestrini and Berlese, 1884.
canestrinii Marchal.
chionaspivorus Ewing, 1911 = *Steneotarsonemus chionaspivorus* (Ewing). New combination in this paper.
chironiae Warburton, 1904.
confusus Ewing, 1939.
contubernalis Reuter, 1906.
culmicolus Reuter, 1900.
destructor Reuter, 1905. Synonym of *Steneotarsonemus pallidus* (Banks) according to Ewing (1939).
dispar, new species in this paper.
equipes Sicher and Leonardi, 1895.
femoralis Ewing, 1939 = *smithi* Ewing. New synonymy in this paper.
fennicum Oudemans, 1915.
floricolus Canestrini and Fanzago, 1876. Synonym of *T. minusculus* according to Oudemans (1926).
fragariae Zimmerman, 1905 = *Steneotarsonemus pallidus* (Banks).
fusarii Cooreman, 1941.
hominis Dahl, 1910.
hydrocephalus Vitzthum, 1939 = *Steneotarsonemus laticeps* (Halbert).
intectus Karpelles, 1886.
interruptus Vitzthum, 1928.
iowensis Ewing, 1939 = *randsi* Ewing. New synonymy in this paper.
kirchneri (Kramer), 1876.
krameri ?
laminifer Ewing, 1939.
laticeps Halbert, 1923 = *Steneotarsonemus laticeps* (Halbert). New combination in this paper.
latipes Ewing, 1939 = *Steneotarsonemus latipes* (Ewing). New combination in this paper.
latus Banks, 1904 = *Hemitarsonemus latus* (Banks).
macronychus Sicher and Leonardi, 1895. Synonym of *T. floricolus* C. and F. according to Berlese (1894).
minimax Vitzthum, 1926.
minusculus Canestrini and Fanzago, 1876.
moliniensis Cooreman, 1947.
occidentalis Ewing, 1939.
oryzae Targioni-Tozetta, 1878.
ovivorus Oudemans, 1927.
pallidus Banks, 1899 = *Steneotarsonemus pallidus* (Banks). New combination in this paper.
pellucens Green, ?
phyragmitidis v. Schlechtendahl, 1896.
phyllophorus Ewing, 1924 = *Steneotarsonemus phyllophorus* (Ewing). New combination in this paper.
pseudosetifer Ewing, 1939. *Nomen dubium.*
randsi Ewing, 1939.
robinii (Kramer), 1876 = *T. floricolus* C. and F.

sauli Dahl, 1910.
scaurus Ewing, 1939.
setifer Ewing, 1939.
simplex Ewing, 1939.
smithi Ewing, 1939.
socialis (Trouessart), 1885 = *T. floricolus* C. and F. according to Berlese (1894).
soricicola Oudemans, 1903.
spinipes Hirst, 1912 = *Steneotarsonemus bancrofti* (Michael).
spirifex Marchal, 1902 = *Steneotarsonemus spirifex* (Marchal). New combination in this paper.
supinoi Sicher and Leonardi, 1895 = *T. floricolus* C. and F. according to Berlese (1894).
tepidariorum Warburton, 1904 = *Hemitarsonemus tepidariorum* (Warburton).
texanus Ewing, 1939.
translucens (Green), (not Nietner, 1861) 1890 = *Hemitarsonemus latus* (Banks).
truncatus Ewing, 1939.
typhae Oudemans, 1929.
ulei ?
uncinatus Flemming, 1884.
unguis Ewing, 1939.
viridis Ewing, 1939 = *Xenotarsonemus viridis* (Ewing). New combination in this paper.
waitei Banks, 1912.
woodi (Rennie), 1918. (Tarsopolipodidae.)

Rhynchotarsonemus, new genus in this paper.
niger, new species in this paper.

Therismoptes Amerling, 1861. *Nomen dubium.*

Xenotarsonemus, new genus in this paper.
viridis (Ewing), 1939.

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EXPLANATION OF PLATES*

PLATE 1

Ventral aspect of a typical (hypothetical) female mite of the genus *Tarsonemus* identifying certain morphological structures with terminology used in the text.

Dorsal and ventral aspects of female *Steneotarsonemus hyaleos*, n. sp.; drawn from allotype.

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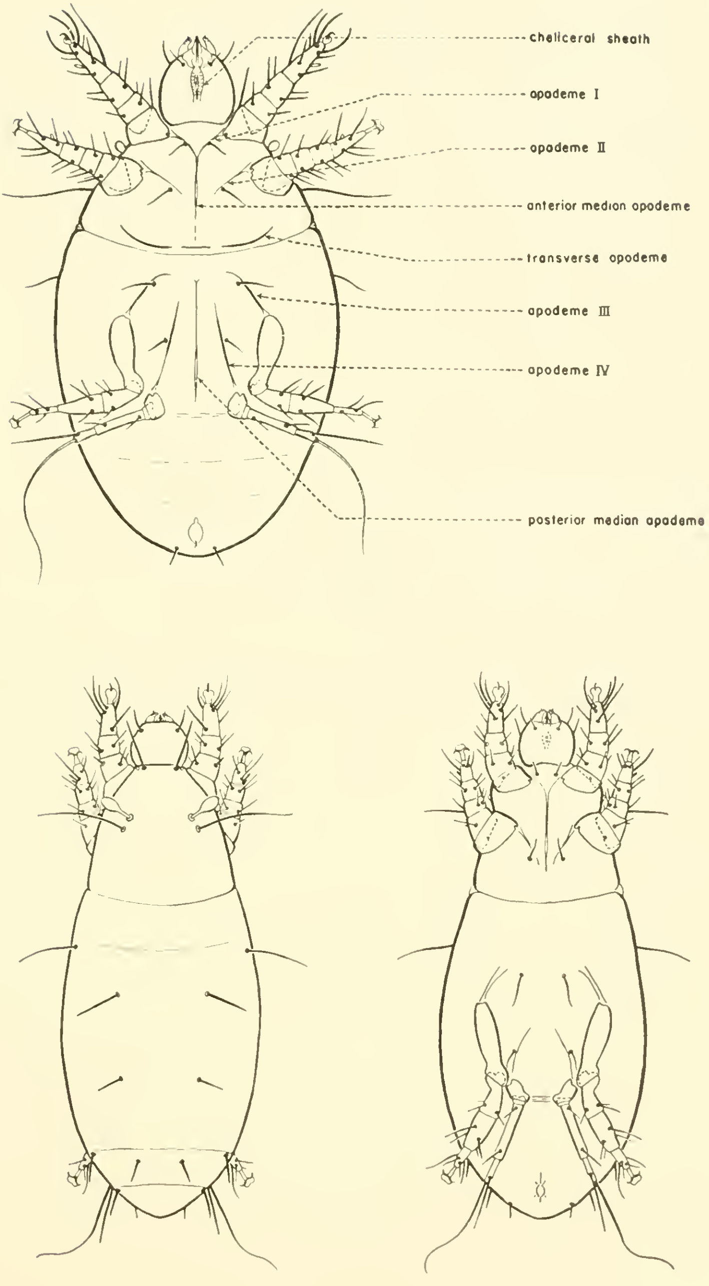
* All drawings of whole mites are made to the same scale of magnification. Tibiotarsal segments of females are presented in identical enlargement as are also the male hind legs and the pseudostigmatic organs figured.

PLATE 1


cheliceral sheath
apodeme I
apodeme II
anterior median apodeme
transverse apodeme
apodeme III
apodeme IV
posterior median apodeme

S. hyaleos

PLATE 2

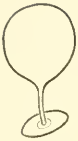
Types of pseudostigmatic organs found in the family Tarsonemidae (same scale of magnification for all species figured).

Dorsal aspects of propodosomal areas of *Tarsonemus waitei* and *Steneotarsonemus phyllophorus* showing position of tracheal atria in relation to dorsal chaetotaxy (same degree of magnification).

Types of transverse apodemes found in females of five species of *Tarsonemus* (diagrammatic).

Lateral aspect of portion of male hysterosoma in the species *Hemitarsonemus latus*, showing natural position of genital papilla, anal plate, etc.

PLATE 2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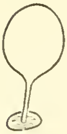
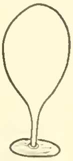
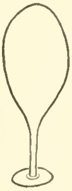
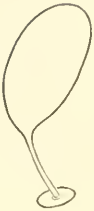

T cryptocephalus


T smithi


R niger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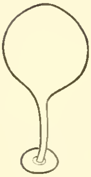
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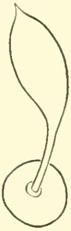
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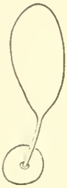
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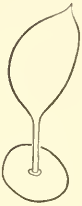
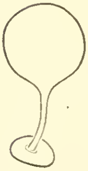
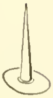
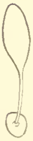
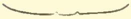

S laticeps


H latus

TYPES OF
PSEUDOSTIGMATIC ORGANS


T. dispar


T simplex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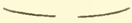
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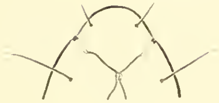
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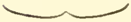
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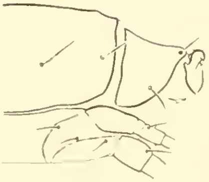
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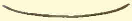
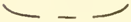

T smithi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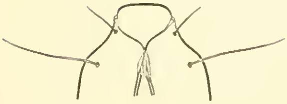
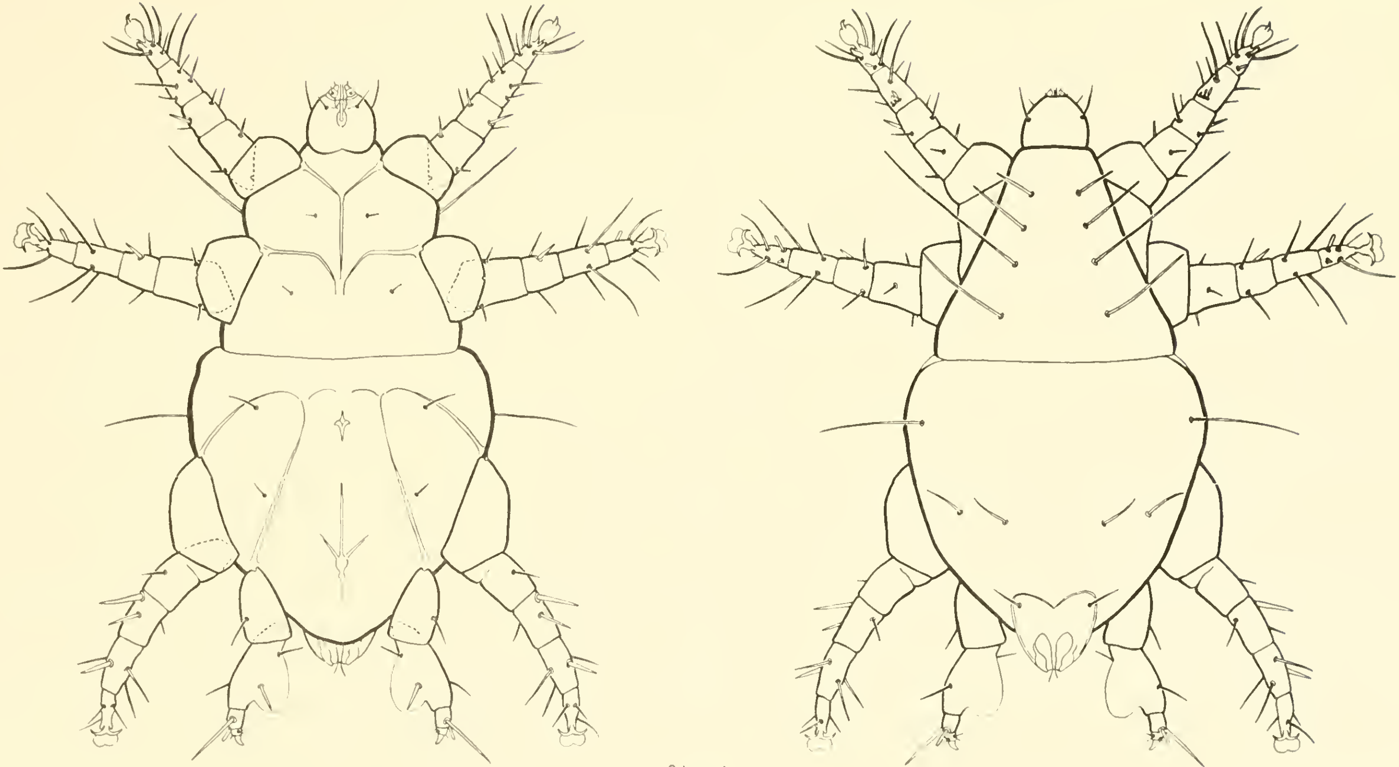

S phyllophorus

TYPES OF
TRANSVERSE APODEMES
♀♀

PLATE 3

Steneotarsonemus bancrofti male in dorsal and ventral aspect.

PLATE 3

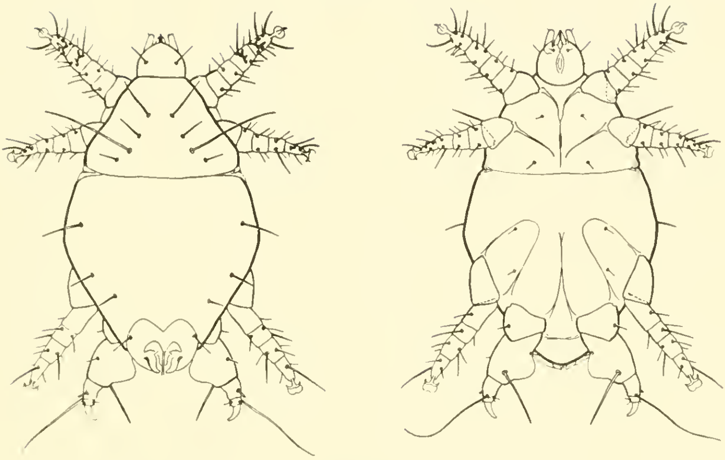


S bancrofti

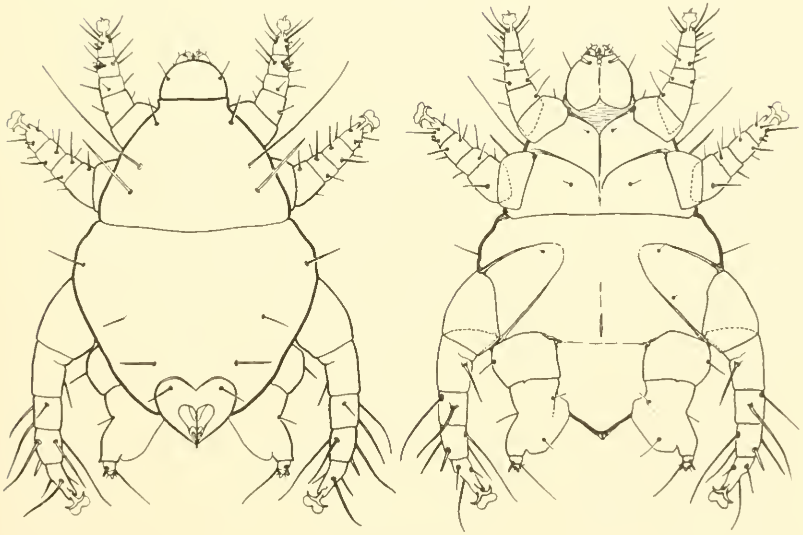
PLATE 4

S. pallidus and *S. phyllophorus* males in dorsal and ventral aspects.

PLATE 4



S. pallidus

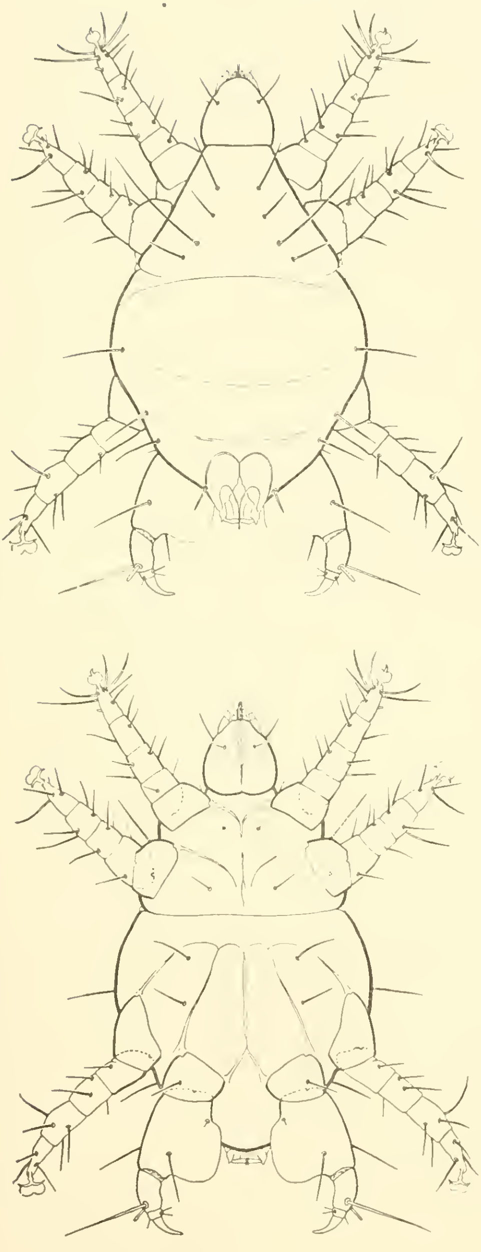


S. phyllophorus

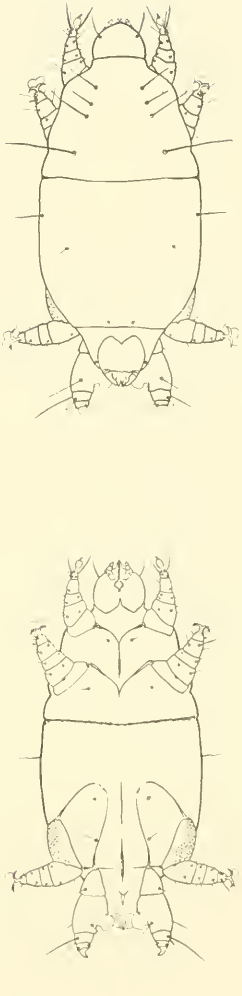
PLATE 5

S. fulgens and *S. hyaleos* males in dorsal and ventral aspects; both drawn from holotype specimens.

PLATE 5



S. fulgens

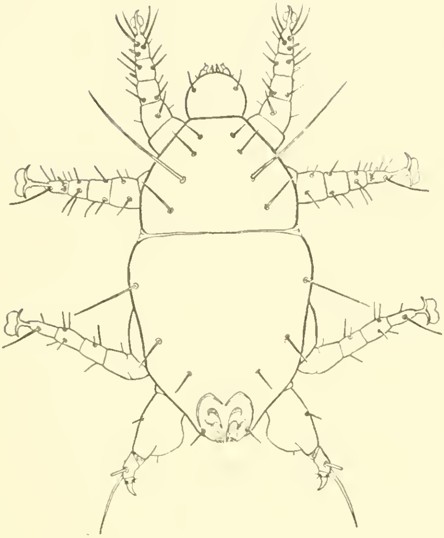


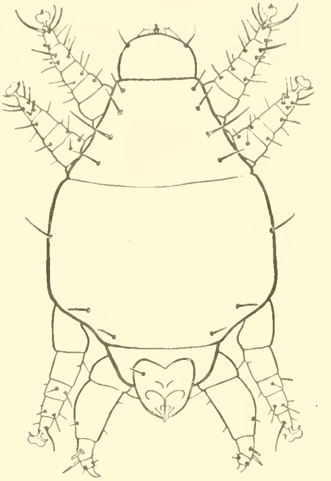
S. hyaleos

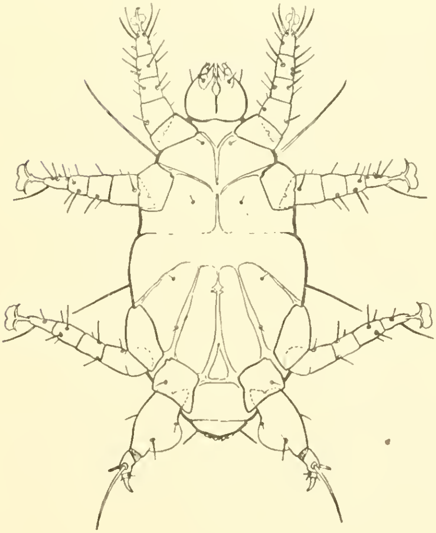
PLATE 6

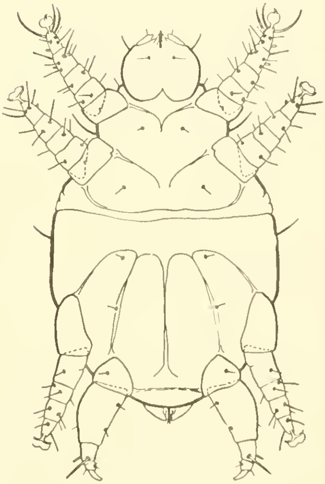
S. ananas and *S. laticeps* males in dorsal and ventral aspects.

PLATE 6









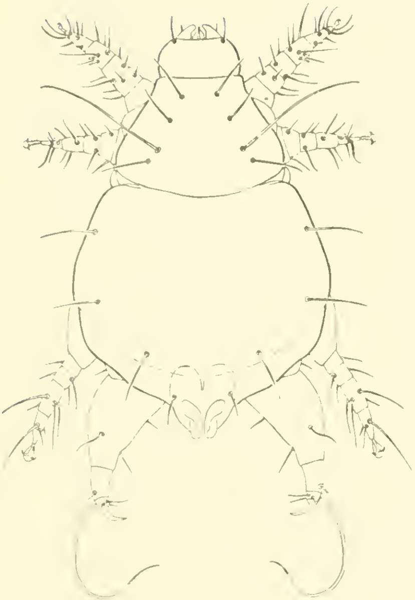
S. laticeps

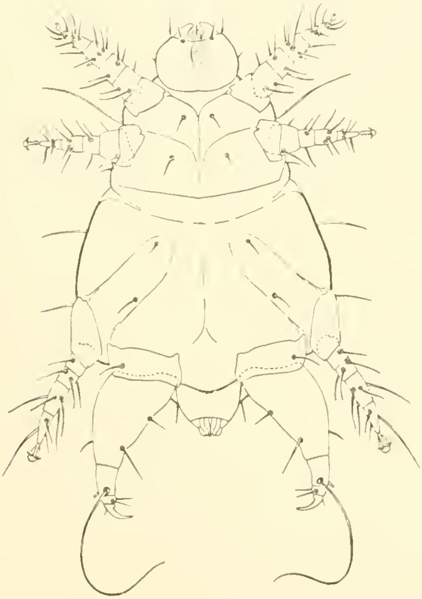
S. ananas

PLATE 7

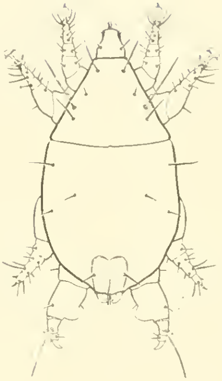
S. chionaspivorus and *S. latipes* males in dorsal and ventral aspects; the latter drawn from cotype.

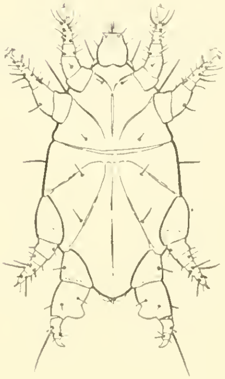
PLATE 7





S chionospivorus



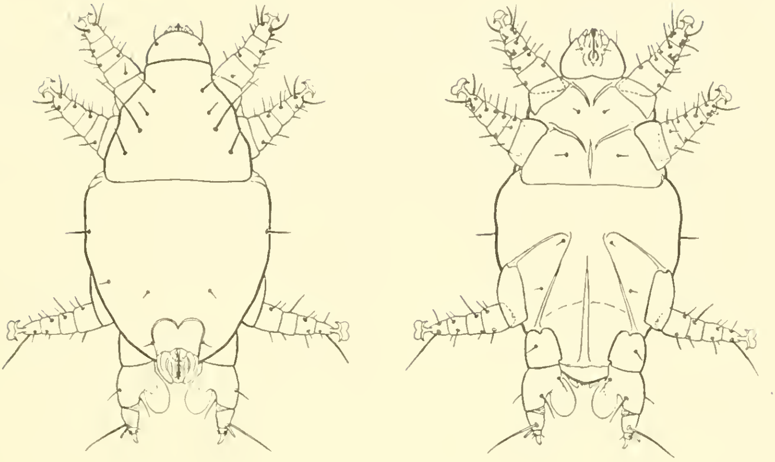


S latipes

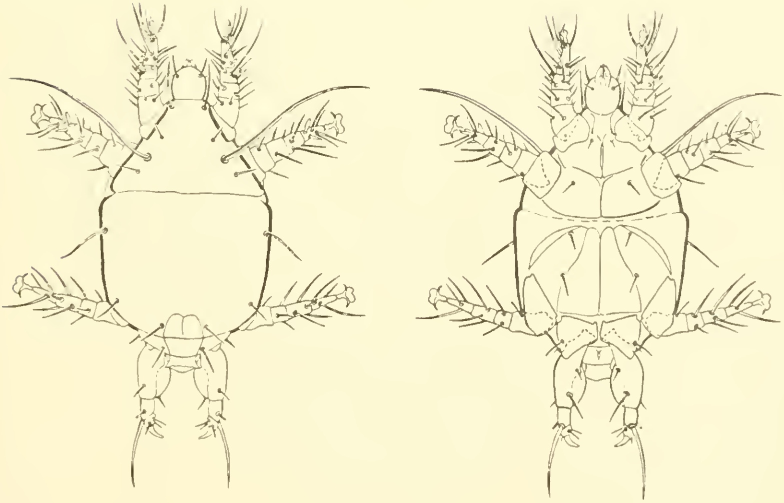
PLATE 8

S. spirifex and *Tarsonemus dispar* males in dorsal and ventral aspects; the latter drawn from holotype.

PLATE 8



S. spirifex

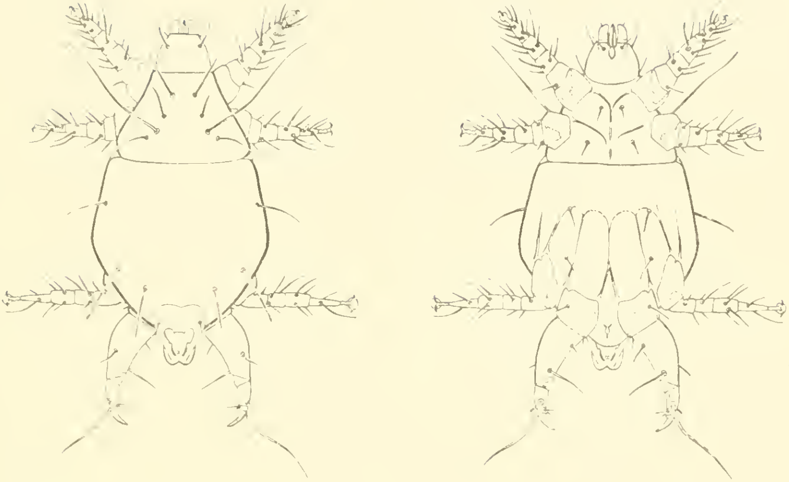


T. dispar

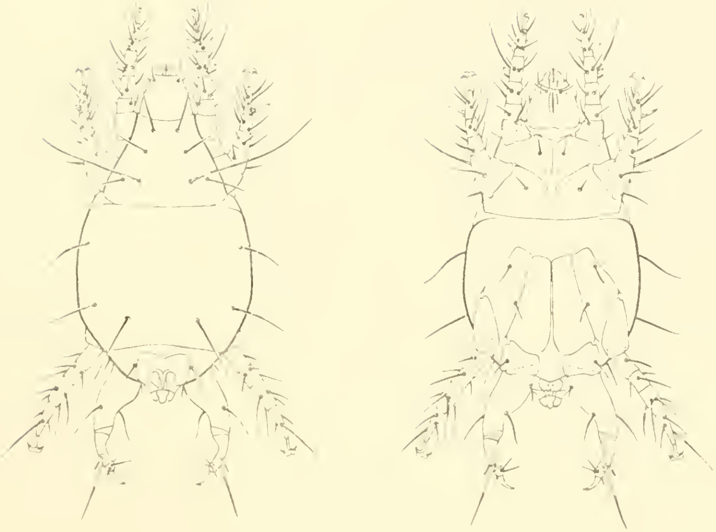
PLATE 9

T. setifer and *T. smithi* males in dorsal and ventral aspects.

PLATE 9



T setifer

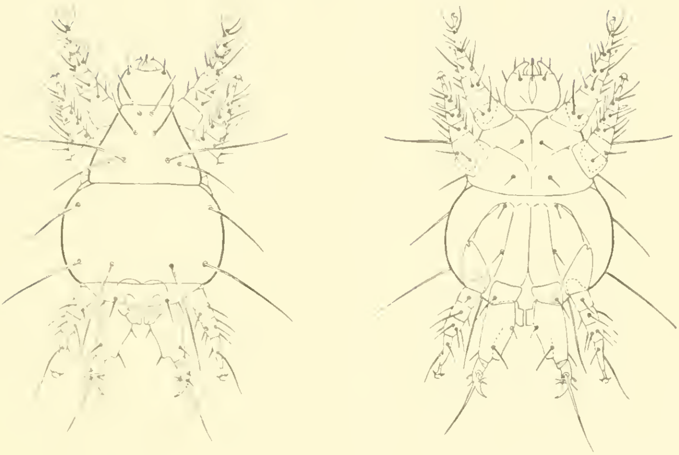


T smithi

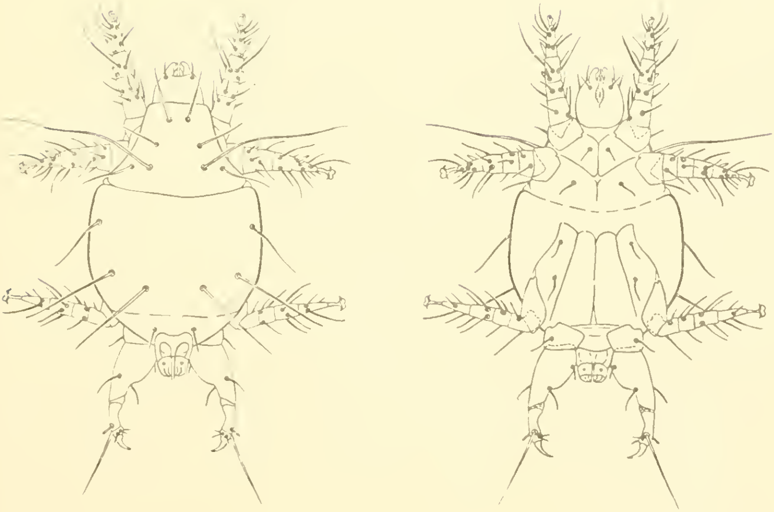
PLATE 10

T. laminifer and *T. sulcatus* males in dorsal and ventral aspects; the latter drawn from holotype.

PLATE 10



T laminifer

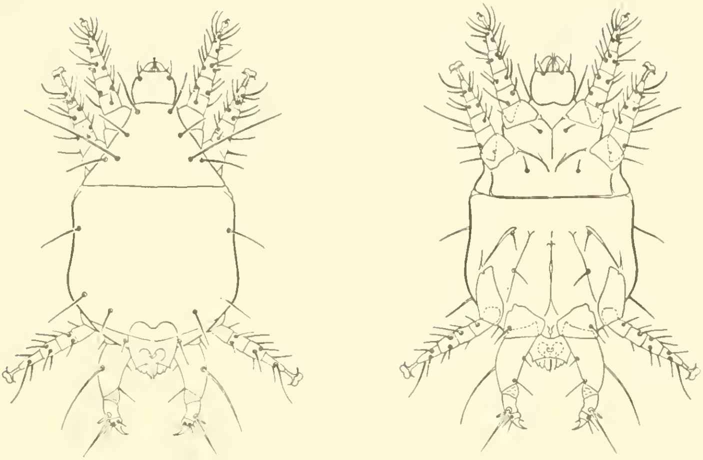


T sulcatus

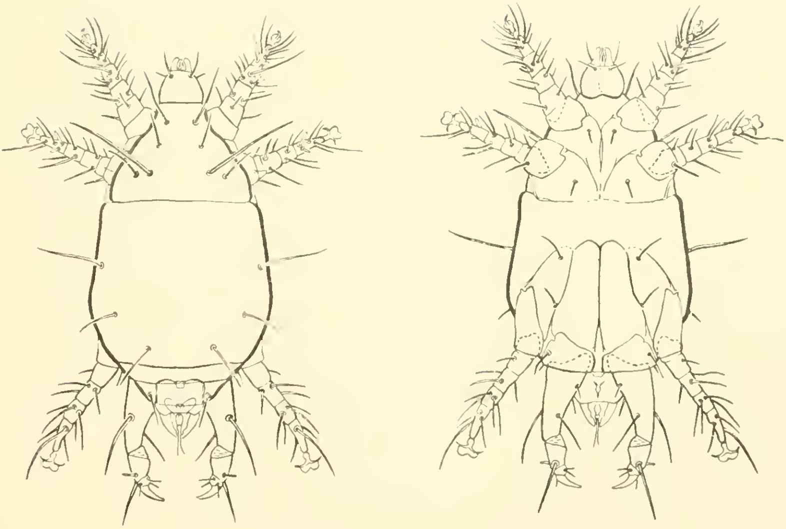
PLATE 11

T. occidentalis and *T. randsi* males in dorsal and ventral aspects; the latter drawn from cotype.

PLATE 11



T occidentalis

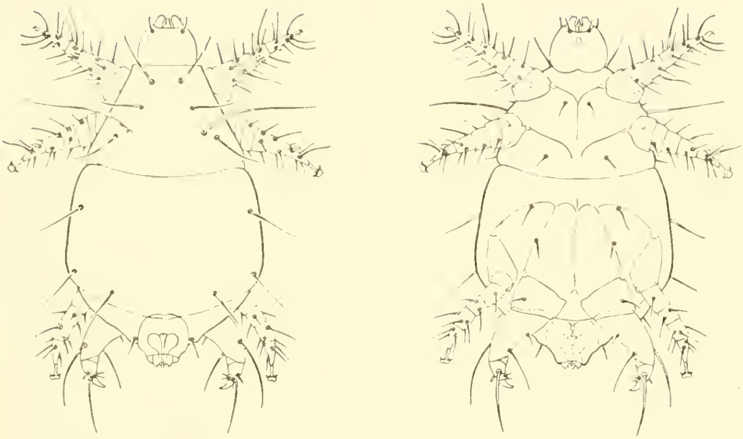


T randsi

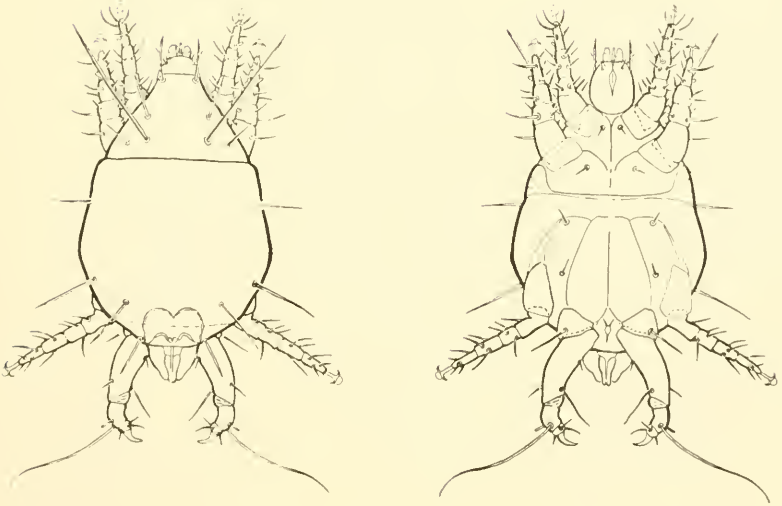
PLATE 12

T. unguis and *T. cryptocephalus* males in dorsal and ventral aspects; the former drawn from type specimen, the latter from cotype.

PLATE 12



T unguis

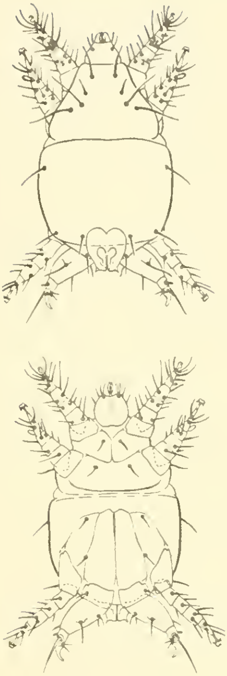


T. cryptocephalus

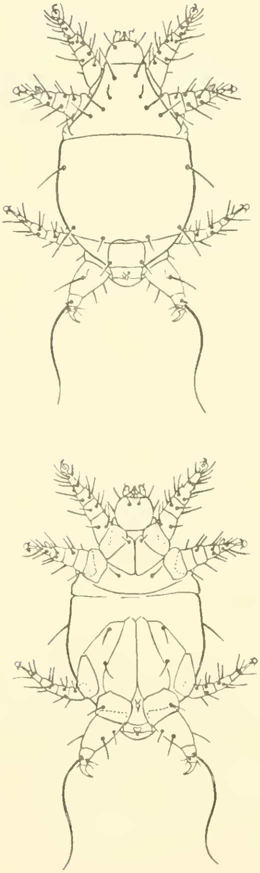
PLATE 13

T. waitei, *T. simplex*, *T. confusus* and *T. pritchardi* males in dorsal and ventral aspects; the latter drawn from holotype.

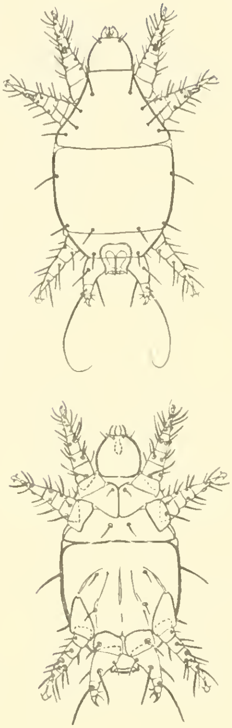
PLATE 13



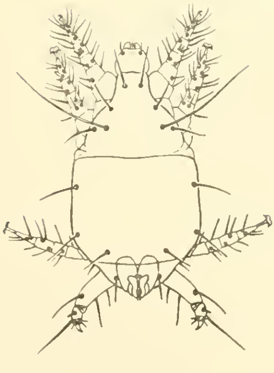
T waitei



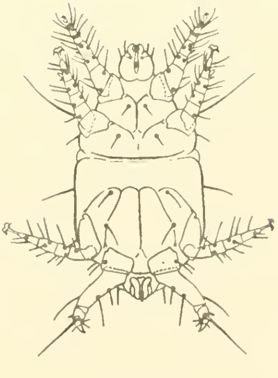
T simplex



C. pritchardi



T. confusus

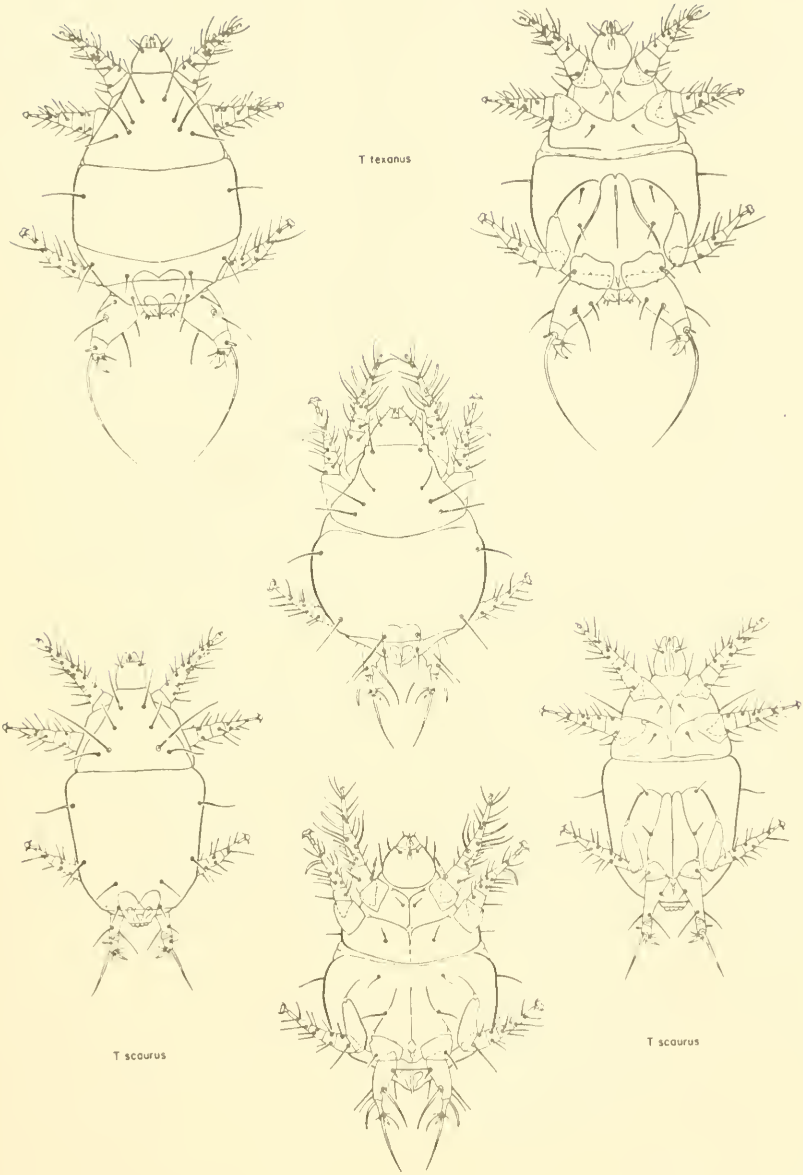


T. confusus

PLATE 14

T. texanus, T. scaurus and *Xenotarsonemus viridis* males in dorsal and ventral aspects.

PLATE 14



T texanus

T scaurus

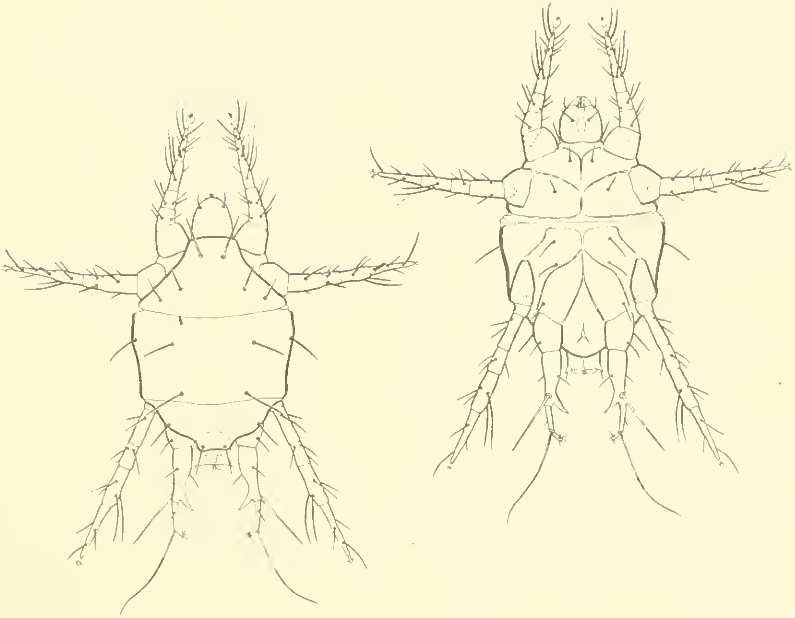
T scaurus

X viridis

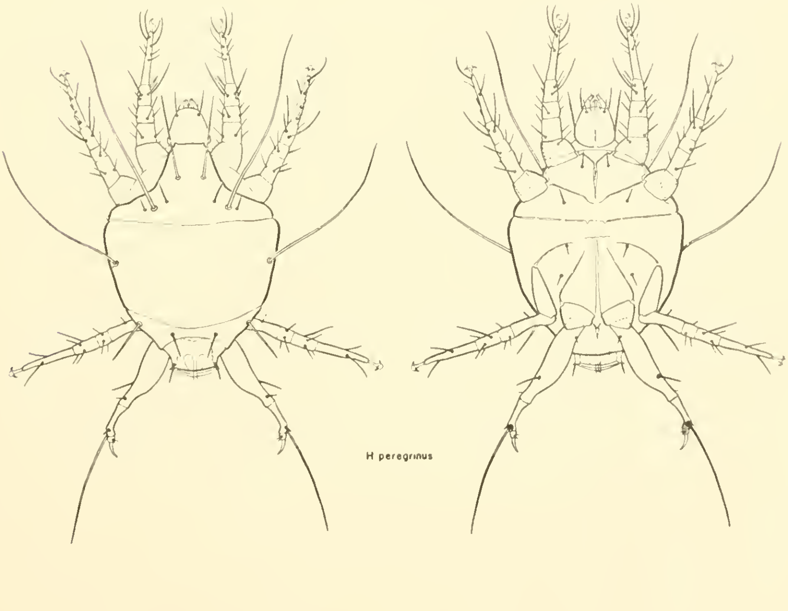
PLATE 15

Hemitarsonemus latus and *H. peregrinus* males in dorsal and ventral aspects; the latter drawn from holotype.

PLATE 15



H latus

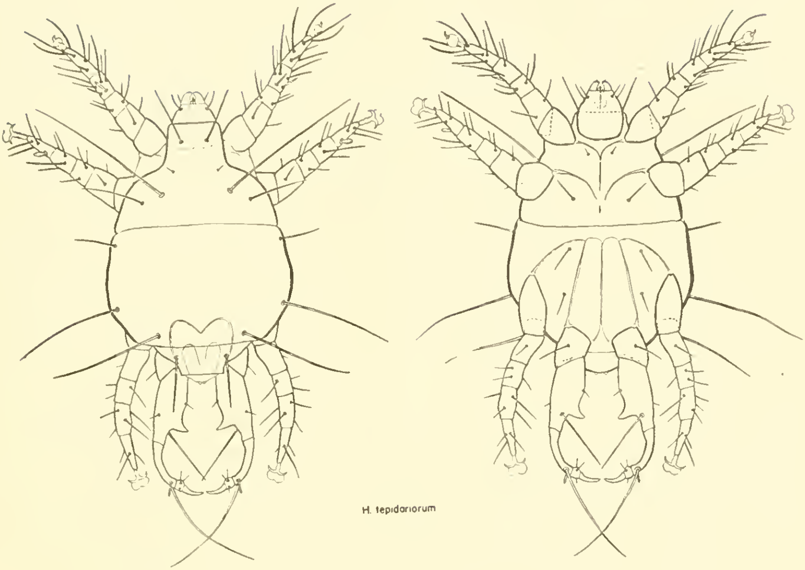


H peregrinus

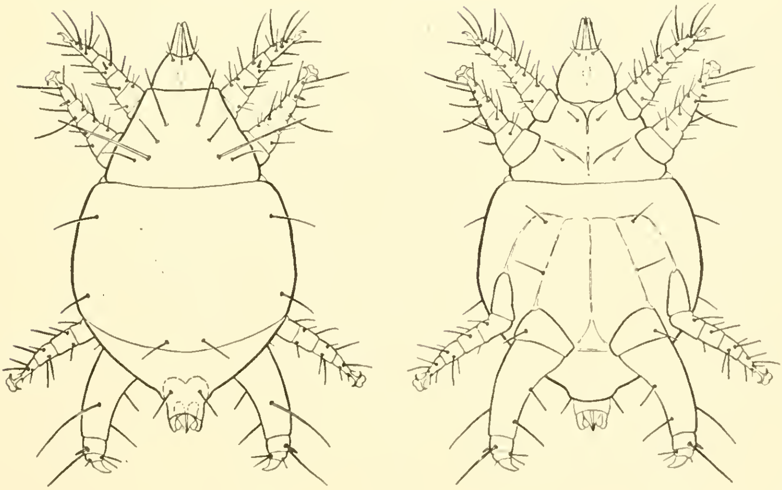
PLATE 16

H. tepidariorum and *Rhynchotarsonemus niger* males in dorsal and ventral aspects; the latter drawn from paratype.

PLATE 16



H. tepidariorum

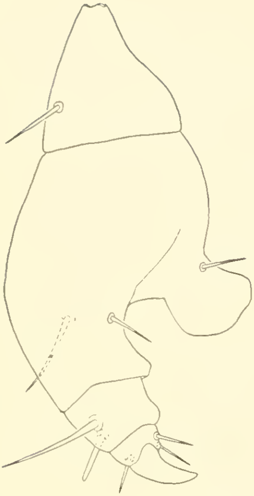


R. niger

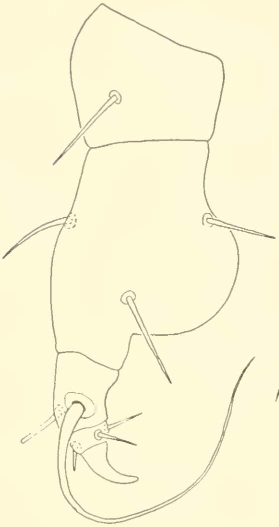
PLATE 17

Hind legs of males in the genus *Steneotarsonemus:*
S. *hyaleos*, n. sp. (drawn from holotype).
S. *ananas.*
S. *spirifex.*
S. *bancrofti.*
S. *phyllophorus.*
S. *pallidus.*

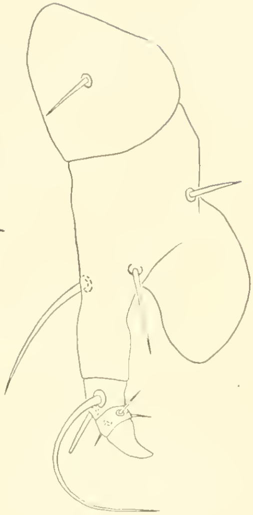
PLATE 17



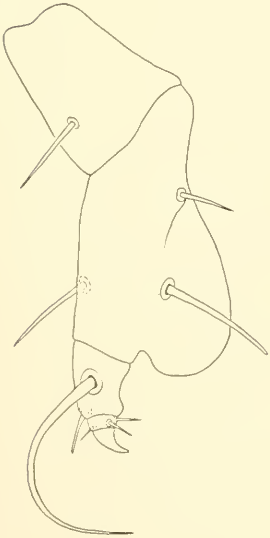
S hyaleos



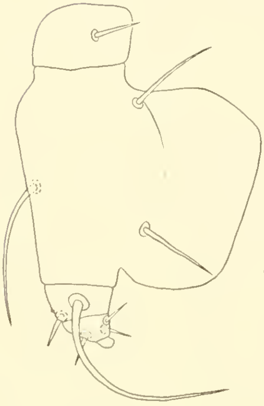
S ananas



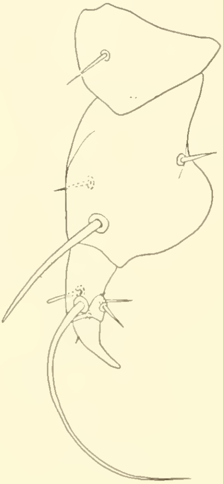
S. spirifex



S. bancrofti



S phyllophorus

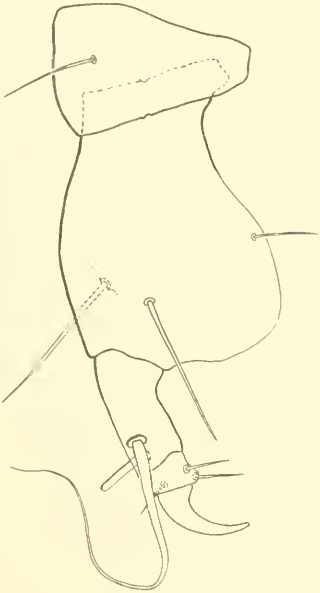


S pallidus

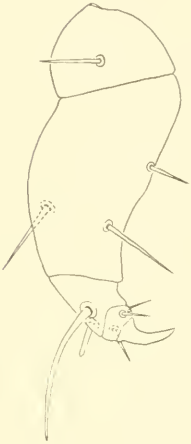
PLATE 18

Hind legs of males:
Steneotarsonemus fulgens, n. sp. (drawn from holotype).
S. laticeps.
S. latipes (drawn from cotype).
Tarsonemus occidentalis.
T. setifer.
T. randsi (drawn from cotype).

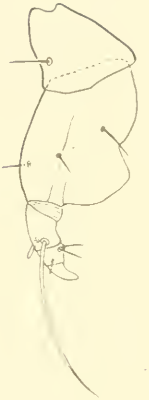
PLATE 18



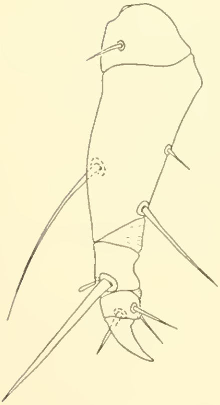
S fulgens



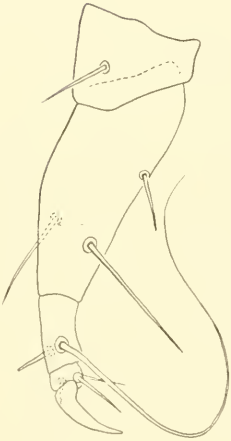
S.laticeps



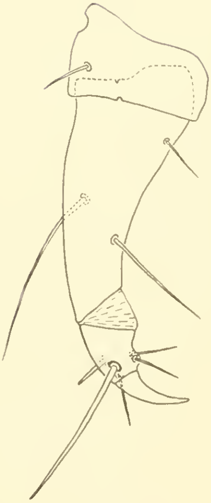
S latipes



T. occidentalis



T setifer



T randsi

PLATE 19

Hind legs of males:

T. smithi.

T. dispar, n. sp. (drawn from holotype).

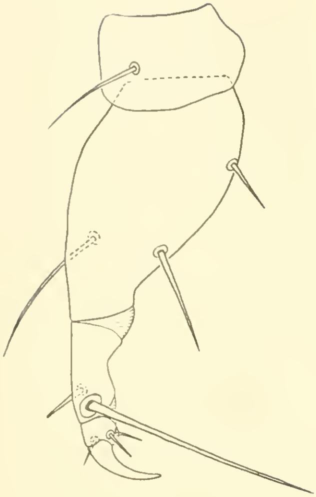
T. sulcatus, n. sp. (drawn from holotype).

T. cryptocephalus (drawn from cotype).

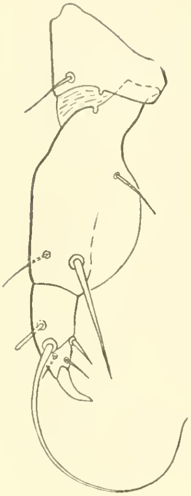
T. laminifer (drawn from cotype).

Steneotarsonemus chionaspivorus.

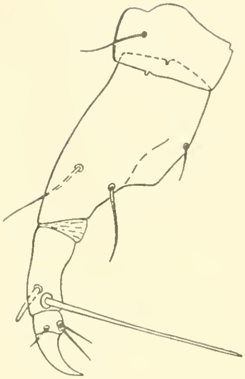
PLATE 19



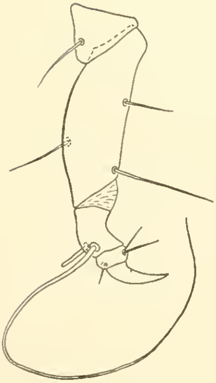
T. smithi



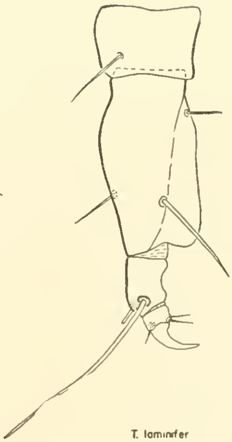
T. dispar



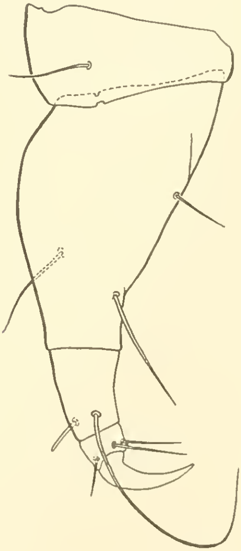
T. sulcatus



T. cryptocephalus



T. laminifer

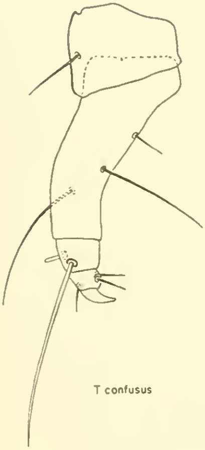


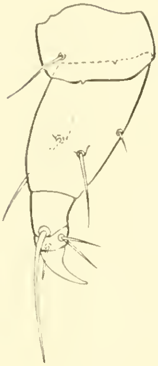
S. chionaspivorus

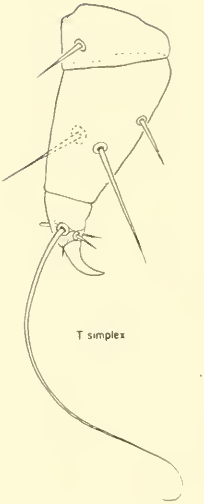
PLATE 20

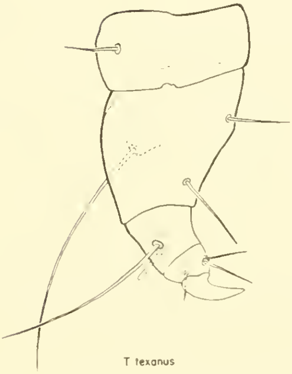
Hind legs of males in the genus *Tarsonemus:*
T. confusus.
T. waitei.
T. simplex.
T. pritchardi, n. sp. (drawn from holotype).
T. texanus (drawn from cotype).
T. scaurus (drawn from cotype).
T. unguis (drawn from type).

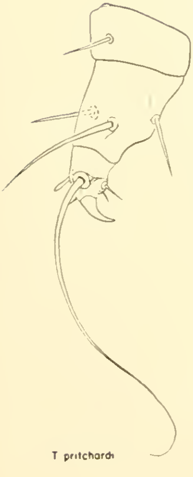
PLATE 20

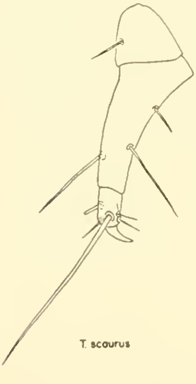

T confusus


T waitei


T simplex


T texanus


T pritchardi


T. scaurus

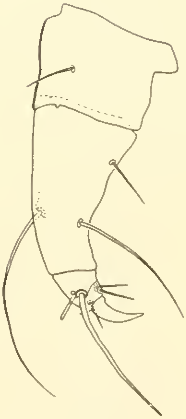

T. unguis

PLATE 21

Hind legs of males:

Xenotarsonemus viridis.

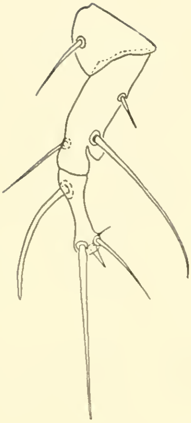
Rhynchotarsonemus niger, n. sp. (drawn from paratype).

Hemitarsonemus tepidariorum.

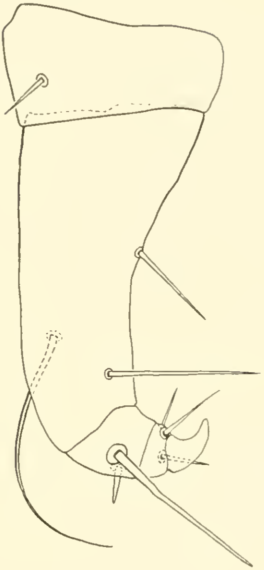
H. peregrinus, n. sp. (drawn from paratype).

H. latus.

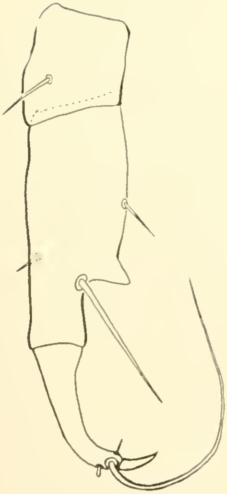
PLATE 21



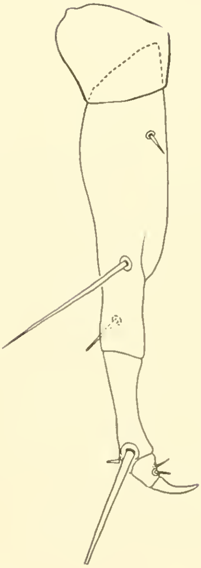
X viridis



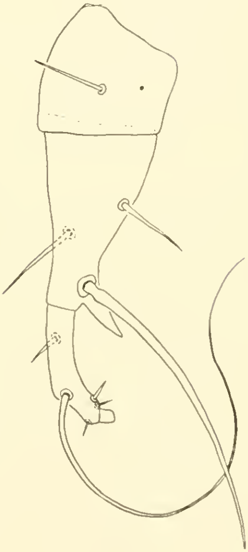
R. niger



H tepidariorum



H. peregrinus

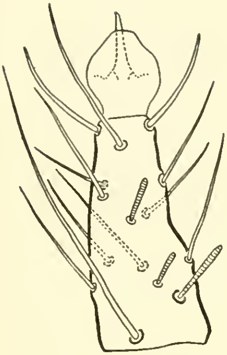


H. latus

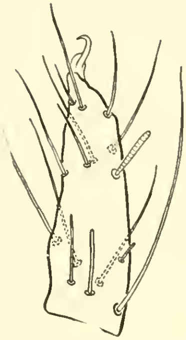
PLATE 22

Tibiotarsal segments of legs I of females in the genus *Steneotarsonemus:*
S. *pallidus.*
S. *fulgens,* n. sp. (drawn from allotype).
S. *ananas.*
S. *hyaleos,* n. sp. (drawn from allotype).
S. *latipes* (drawn from cotype).
S. *phyllophorus.*
S. *spirifex.*
S. *laticeps.*
S. *bancrofti.*

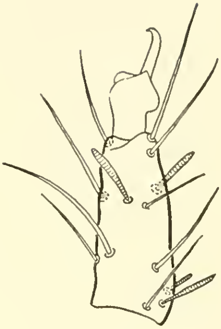
PLATE 22



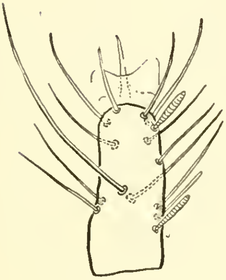
S. pallidus



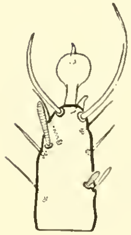
S fulgens



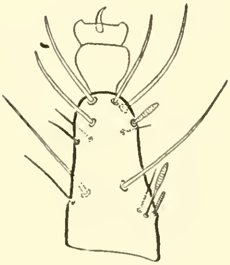
S. ananas



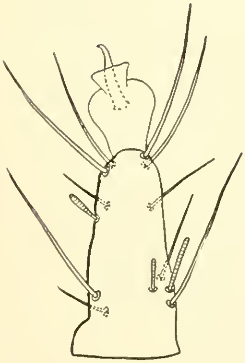
S.hyaleas



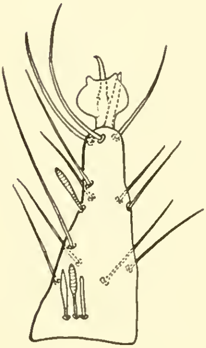
S latipes



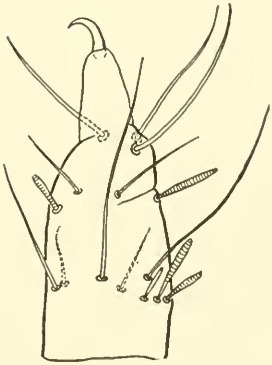
S phyllophorus



S spirifes



S.laticeps

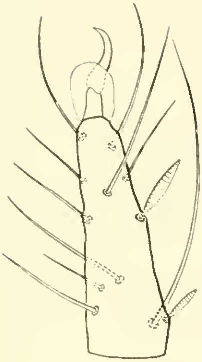


S. bancrofti

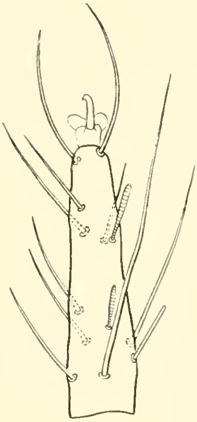
PLATE 23

Tibiotarsal segments of legs I of females:
Steneotarsonemus chionaspivorus.
Tarsonemus occidentalis.
T. setifer.
T. randsi (drawn from cotype).
T. sulcatus, n. sp. (drawn from allotype).
T. smithi.
T. dispar, n. sp. (drawn from paratype).
T. cryptocephalus (drawn from cotype).

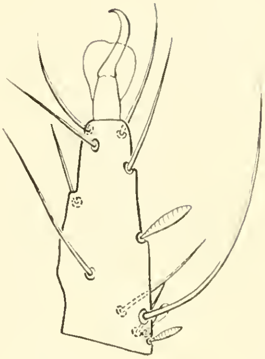
PLATE 23



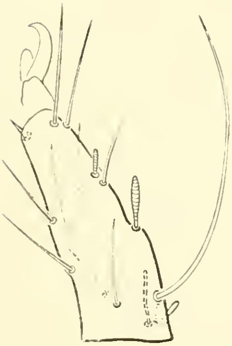
T occidentalis



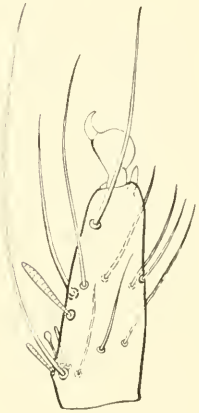
T setifer



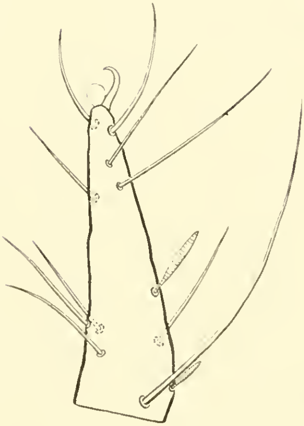
T randsi



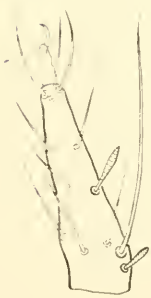
T sulcatus



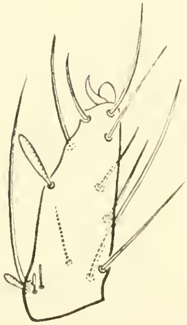
T. dispar



T smithi



S. chionaspivorus

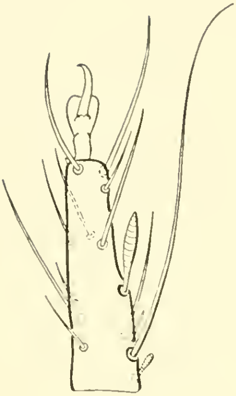


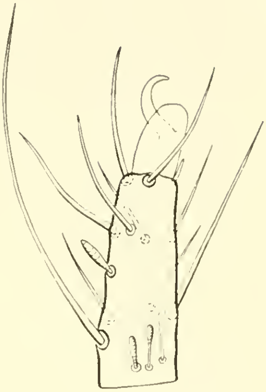
T cryptocephalus

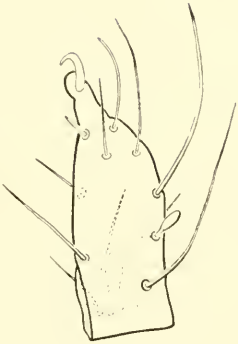
PLATE 24

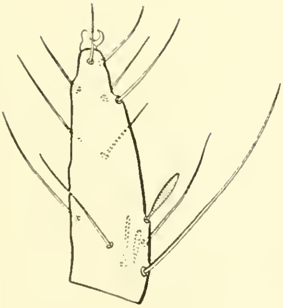
Tibiotarsal segments of legs I of females in the genus *Tarsonemus:*
T. confusus.
T. simplex.
T. waitei.
T. pritchardi, n. sp. (drawn from allotype).
T. scaurus (drawn from cotype).
T. texanus.

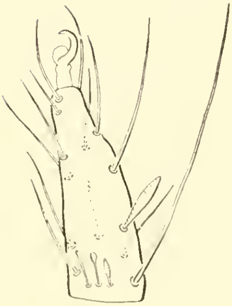
PLATE 24


T confusus


T waitei


T simplex


T pritchardi


T texanus

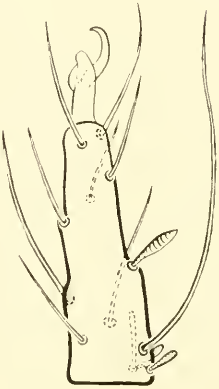
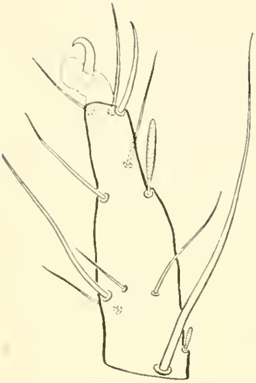

T scaurus

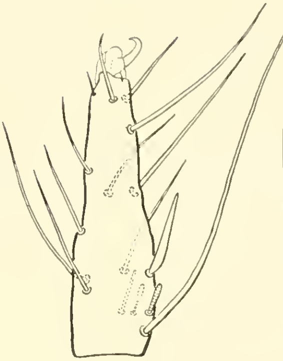
PLATE 25

Tibiotarsal segments of legs I of females:
Rhynchotarsonemus niger, n. sp. (drawn from paratype).
Xenotarsonemus viridis.
Hemitarsonemus peregrinus, n. sp. (drawn from paratype).
H. latus.
H. tepidariorum.

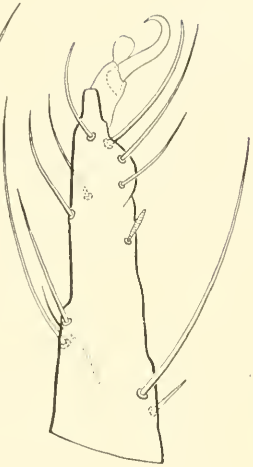
PLATE 25



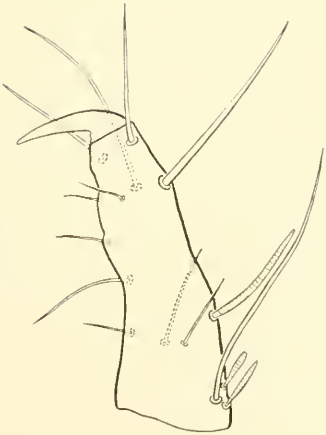
R niger



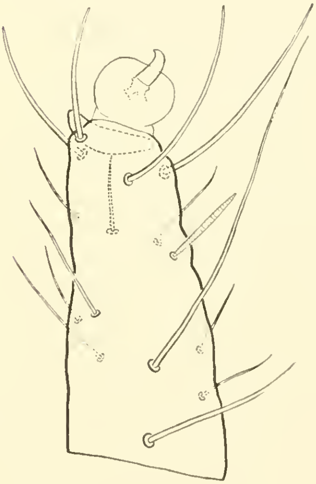
X viridis



H peregrinus



H latus



H tepidariorum

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THE UNIVERSITY OF KANSAS
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Effect of Radioactive Phosphorus (P^{32}) on the Blood Cells and Other Tissues of the Cotton Rat, *Sigmodon hispidus*

By

ROBERT M. HANKINS

ABSTRACT.—The cotton rat, *Sigmodon hispidus*, is a valuable addition to the series of animals useful for laboratory purposes. It quickly adapts itself to laboratory conditions and is easily reared. Its response to irradiation induced by intraperitoneal injections of radioactive phosphorus (P^{32}) is not markedly different from that expressed in other laboratory animals.

Cotton rats reproduce readily in small cages if a small metal can or box is provided as a breeding hutch. In the colony maintained by the Department of Zoology at the University of Kansas, litters were produced at an average interval of 32.7 days; litters averaged 5.2 young each. Shortest intervals between litters occurred in a female that produced young at intervals of 25 and 26 days; size of litters varied between one and 11 young.

Normal values for erythrocyte volume, sedimentation rate, haemoglobin, total erythrocyte—and leucocyte-numbers and differential leucocyte counts are given, and seven graphs show the effects of radiation upon each of these constituents of the blood, and upon several tissues and organs. Thirteen tables and one graph present data on breeding records of *Sigmodon*, age at sexual maturity, number of young per litter, growth rates of males and females, determination of LD 50/30-day dosage of P^{32} for *Sigmodon*, values of several constituents of the blood before and after irradiation, and the rate of loss of P^{32} from tissues and organs following treatment with radioactive phosphorus.

The LD 50/30-day dosage of P^{32} for *Sigmodon* is determined to be 4.3 microcuries per gram of body weight.

INTRODUCTION

The purpose of this paper is to report the effects of irradiation by beta particles from internally administered P^{32} on the formed elements in the blood of the native rodent, *Sigmodon hispidus texianus* (Audubon and Bachman). In addition, a description of the details of animal care, breeding habits, and maintenance of a colony of *Sigmodon* are included. This report is one of a series of studies originating in this laboratory on the biology of *Sigmodon.* Hankins (1951) established the normal values of each of the cellular components of the blood of the cotton rat; Dolyak and Leone (1953) established normal values for some of the components of the plasma; Keys and Leonard (1952) studied the development of the cotton rat through the first nine and one-half days of gestation; Leone, Dolyak, and Truffelli (1952) studied isoagglutination and heteroagglutination of the erythrocytes of the cotton rat, and the reactions of the plasmas of cotton rats with human erythrocytes; Phillips, Leonard, and Leone (1952) studied the effects of large single doses of radiophosphorus on the bone marrow of the sternum, and Overend, Leonard, and Leone (1952) presented a semi-quantitative study of the effects of radiophosphorus on the spleen.

The cotton rat has been successfully used in our laboratory for the Kelso modification of the Ascheim-Zondek test for pregnancy. The animal is adaptable to some bacteriological and parasitological studies related to problems of public health; it is, for example, a good host for certain North American ticks, with which guinea pigs and other commonly used exotic laboratory animals are incompatible.

The cotton rat was selected as the experimental animal for these studies in order to add to the knowledge of the effects of radiation on native animals.

Assistance from Professors A. Byron Leonard, Charles A. Leone, and E. Raymond Hall is acknowledged. This research was made possible by a project conducted under the terms of cooperative contract no. AT (11-1)-26 between the University of Kansas and the United States Atomic Energy Commission.

ANIMALS AND THEIR CARE

Origin of the Colony

The cotton rat has been used as a laboratory animal for the past ten years or longer. Meyer and Marsh (1943) studied the development and maintenance of laboratory colonies of the cotton rat. Meyer and Meyer (1944) expanded the use of this rodent as an experimental laboratory animal. Meyer and Marsh (in Worden, 1947:178-183) discussed the development and management of a cotton-rat colony.

The original colony at the University of Kansas was started from 25 animals trapped within a radius of 10 miles of Lawrence, Douglas County, Kansas, and 53 animals trapped in a small area 8 miles northwest of Norman, Cleveland County, Oklahoma. From these animals 20 pairs were selected as breeding stock and the remaining 38 individuals were used in early experimental work. Other animals were trapped in Douglas County, Kansas, and added to the colony from time to time. Breeding in the laboratory has been successful and for a time reproduction in the colony was at the rate of approximately 100 young per month from 20 pairs of animals.

MATERIALS AND METHODS

Two types of cages are used for housing the breeding animals. The cages that have proven best are of frame construction with a solid bottom of wood; sides and tops are wire mesh. Cages are built in batteries of six, each of which, in inches, is 20 by 12 by 15, and opens at the top. Cages of the second type are metal with wire-mesh sides and top and a detachable base containing pans, which can be removed for cleaning. The metal cages are built in batteries of three. Eight batteries are placed in one rack. The individual cages, in inches, are 12 by 12 by 12. Cages constructed of wood are more difficult to clean but the solid bottom is preferable for raising young. Cages with wire bottoms of 4 to 8 mesh per inch can be used for raising young, but droppings and other waste do not fall through into the pans beneath. The young are frequently injured severely on wire-mesh bottoms of less than 4 strands of wire per inch.

It is essential that animals have a constant supply of water and proper feed. Cotton rats readily learn to drink from standard water bottles. Waste of feed is kept to a minimum in cages with solid bottoms. Some type of feeder which cannot be overturned and in which it is difficult to scratch is necessary in cages with wire bottoms. Cotton rats are both selective and wasteful in their feeding habits in the laboratory, but growth and reproduction is best when the rats are allowed to select what they want to eat from mixed feed. Commercially prepared feeds alone are not satisfactory for a breeding colony. The best results were obtained by feeding the animals whole-grain wheat and oats mixed with "Friskies Dog Meal" or some other high protein product. Sunflower seeds are also a good food but high cost prohibits their use in quantity. In our laboratory, lettuce and carrots are also fed to the rats once each week.

Cages are cleaned once each week and clean wood shavings placed on the floor as an absorbent. Shavings cannot be used in cages with wire mesh bottoms but can be used as an absorbent in the dropping pans.

Temperature is an important factor in breeding. The animal room in which these rats are housed is maintained at 70° F. to 80° F. At temperatures above this range, reproduction declines and at temperatures below this range reproduction stops. Darkening of cages has no effect on breeding. It has been found, however, that a small breeding hutch in the cage is conducive to reproduction. For this purpose metal cans (7 inches by 4¼ inches) are provided in each cage.

DATA ON BREEDING

After animals are paired for reproduction the male and female are left together continuously. Occasional antagonism between them may result in the death of the male, but over-all incidence of death or serious injury to males does not present a great problem. Incompatibility most frequently follows parturition, but since post-parturition copulation is common in the cotton rat, it is desirable to leave mated pairs together during this period in order to secure the maximum rate of reproduction.

Several females can be kept together in the same cage but males cannot be housed together unless they are placed in the same cage before they reach the age of four weeks; they will then live together harmoniously indefinitely. Once separated for any length of time, however, males tend to become antagonistic toward one another and should not be placed together again.

The gestation period of the cotton rat, according to Meyer and Meyer (1944) is 27 days. Observations made on 12 pairs of rats in our colony age given in table 1. One female (No. 2036) gave birth to a litter 26 days following the previous one; she bore a subsequent litter 25 days later. These were the only instances of gestation periods of less than 27 days. The average length of the period between litters among these 12 pairs was 32.7 days; the shortest average period between litters borne by a single female was 27.1 days.

Length of the reproductive life of the cotton rat is not positively known. One male in our colony remained sexually productive for more than two years. Most females more than one year old have small litters and are not desirable as breeding stock after reaching that age. Animals of both sexes reach sexual maturity at approximately two and one-half months. The age of females at first conception ranged from 45 to 99 days; the average age at the first conception was 74.4 days (see table 2). Under controlled labora-

TABLE 1

Breeding Records showing Time of Year and Interval between Litters for Continuously Paired *Sigmodon hispidus texianus*

Animal	1st litter	2nd litter	no. days	3rd litter	no. days	4th litter	no. days	5th litter	no. days	6th litter	no. days	7th litter	no. days	8th litter	no. days	9th litter	no. days	10th litter	no. days	Ave.
2019	11/8/49	12/6/49	28	1/29/50	54	2/25/50	27	3/27/50	30	4/23/50	27	5/21/50	28	6/29/50	39	8/1/50	33	9/1/50	31	33.0
2036	1/26/50	2/23/50	28	3/28/50	33	4/25/50	28	5/21/50	26	6/9/50	49	7/8/50	30	8/2/50	25	...	...	...	...	31.3
2053	3/8/50	4/3/50	26	4/30/50	27	5/27/50	27	6/23/50	27	7/21/50	28	8/18/50	28	9/14/50	27	...	...	...	...	27.1
2062	3/26/50	4/22/50	27	6/5/50	44	7/3/50	28	8/1/50	29	8/28/50	27	...	...	...	...	...	...	...	...	31.0
2003	11/15/49	12/23/49	38	2/3/50	42	3/11/50	36	4/11/50	31	5/14/50	33	...	...	...	...	...	...	...	...	36.0
2047	3/30/50	5/10/50	41	6/18/50	39	7/16/50	28	8/13/50	28	...	...	...	...	...	...	...	...	...	...	34.0
2001	3/19/49	6/14/49	87	9/30/49	108	10/28/49	29	...	...	...	...	...	...	...	...	...	...	...	...	74.7
2038	2/12/50	3/15/50	31	4/26/50	42	5/26/50	30	...	...	...	...	...	...	...	...	...	...	...	...	34.3
2135	5/25/50	6/22/50	28	8/20/50	52	9/17/50	28	...	...	...	...	...	...	...	...	...	...	...	...	36.0
2048	3/7/50	4/26/50	50	5/23/50	27	...	...	...	...	...	...	...	...	...	...	...	...	...	...	38.5
2068	3/17/50	4/26/50	40	5/24/50	28	...	...	...	...	...	...	...	...	...	...	...	...	...	...	34.0
2136	6/2/50	6/30/50	28	7/27/50	27	...	...	...	...	...	...	...	...	...	...	...	...	...	...	27.5
Average			37.7		43.6		29.0		28.5		32.8		28.7		30.3		33.0		31.0	32.7

tory conditions *Sigmodon* is productive throughout the year (see tables 1 and 2).

Asdell (1946:239) indicates that females from different wild populations bear litters of different sizes. He suggests also, that diet influences litter size. From the observations made on our colony it seems that litter size depends also on the age of the female and on the number of previous litters borne by her. Observations made on 80 litters borne by 24 pairs of animals are shown in table 3. The number of young in a litter varies from 1 to 11; the average number per litter is 5.2. The second litter usually contains more young than the first. The average number in first litters was 4.9 young; second litters averaged 5.4 young. Litters having the largest number of young are the third, fourth and fifth with average numbers of 5.8, 5.6, and 5.8 respectively. A decline in number of young per litter is noted in the sixth litter which has an average number of 5.0. The sample (number of litters) is small for litters 4, 5 and 6 and does not provide sufficient data for a meaningful statistical comparison with litters 1, 2, and 3. The average number of young per litter of *Sigmodon* reported by Svihla (1929), Meyer and Meyer (1944) and Rinker (1942) compared with that found in the colony in our laboratory are shown in table 4.

TABLE 2

Sexual Maturity of Female *Sigmodon*

Animal	Birth date	First litter	Age in days at birth of first litter	Approximate age in days at conception
2035	9-30-49	2-3-50	126	99
2036	9-30-49	1-26-50	118	91
2038	10-16-49	2-12-50	119	92
2066	11-15-49	3-3-50	108	81
2146	2-12-50	5-22-50	99	72
2163	4-22-50	7-16-50	85	58
2165	4-23-50	7-16-50	87	60
2168	3-8-50	5-23-50	76	49
2169	3-8-50	7-11-50	124	97
2171	3-15-50	5-26-50	72	45

Meyer and Marsh (1943) cautioned that the handling of newborn young should be avoided to prevent harm to them by their mother. In our laboratory we have noted no disturbance attributable to handling of the young. They are sexed, weighed and marked shortly after birth without any deleterious effects.

Growth rate in three litters is shown in table 5 with the median and range of weights for 23 animals from one to 71 days of age.

TABLE 3

Numbers of *Sigmodon* per Litter

Animal	1st	2nd	3rd	4th	5th	6th	Average
2019.....	3	4	4	6	7	6	5.0
2036.....	3	2	6	5	5	6	4.5
2053.....	6	6	8	4	7	7	6.3
2062.....	7	6	6	6	6	4	5.8
2003.....	4	5	4	6	2	2	3.8
2047.....	9	11	8	6	8	....	8.4
2001.....	4	6	4	3	....	....	4.3
2038.....	4	6	7	6	....	....	5.8
2135.....	4	6	7	8	....	....	6.3
2048.....	8	7	6	....	....	....	7.0
2068.....	3	4	5	....	....	....	4.0
2136.....	2	7	5	....	....	....	4.7
2052.....	5	7	....	....	....	....	6.0
2066.....	6	6	....	....	....	....	6.0
2093.....	5	5	....	....	....	....	5.0
2139.....	4	5	....	....	....	....	4.5
2140.....	6	6	....	....	....	....	6.0
2144.....	8	6	....	....	....	....	7.0
2146.....	4	4	....	....	....	....	4.0
2168.....	6	5	....	....	....	....	5.5
2171.....	6	6	....	....	....	....	6.0
2040.....	3	2	....	....	....	....	2.5
2035.....	5	6	....	....	....	....	5.5
2008.....	3	1	....	....	....	....	2.0
Average..	4.9	5.4	5.8	5.6	5.8	5.0	5.2

TABLE 4

Numbers of *Sigmodon* per Litter as reported by various investigators

Investigator	Range	Average litter size
Svihla........................	3–8	4.7
Meyer and Meyer...............	2–10	5.6
Rinker........................	5–10	7.4
Hankins.......................	1–11	5.2

Data are given for a large litter of 11 young, a litter of eight and a small litter of four. The average growth of 12 females and 11 males is expressed graphically in Fig. 1. There is little difference in the weight of males and females at birth although males are slightly heavier. The rate of gain in weight of males and females runs parallel up to the approximate age of 36 days when the males begin to increase in weight more rapidly than females. Fully mature, laboratory-reared cotton rats are considerably heavier than those trapped from nature. Laboratory-reared females at the age of one year weigh 240 to 260 grams; males, 275 to 300 grams.

TABLE 5

Weights in Grams of Male and Female *Sigmodon* from Birthday to 71 Days of Age

Age in days	Litter No. 1 (11 animals)				Litter No. 2 (8 animals)				Litter No. 3 (4 animals)			Average of all litters	
	6 Females		5 Males		3 Females		5 Males		3 Females		1 Male	Males	Females
	Median	Range	Median	Range	Median	Range	Median	Range	Median	Range			
1	6.0	5.9–6.2	6.4	5.3–6.6	5.9	5.5–6.6	6.6	5.1–6.8	6.0	5.4–6.4	5.1	6.4	6.0
3	8.1	7.9–8.3	8.2	7.3–8.8	7.1	7.0–8.0	7.7	6.4–8.1	7.0	6.2–6.9	6.5	7.7	7.1
5	9.6	9.3–10.0	9.0	8.4–10.3	8.7	8.0–9.2	9.4	7.8–9.8	9.1	7.7–9.4	8.5	9.0	9.1
7	12.0	11.4–12.3	11.9	10.8–12.5	10.3	9.6–10.4	10.2	9.7–10.5	12.5	11.4–13.8	11.6	11.6	12.0
9	15.3	14.0–16.9	15.1	13.9–17.0	12.8	12.2–13.0	13.1	11.4–13.1	15.9	14.1–17.0	15.0	15.0	15.3
15	22.5	20.0–24.4	22.8	20.4–24.5	20.0	20.0–20.7	20.5	24.4–23.0	22.5	18.2–29.9	21.6	21.6	22.5
22	32.2	30.0–35.7	33 0	29.4–35.8	27.6	25.4–29.1	31.1	30.0–32.6	28.7	36.5–40.9	36.5	33.0	28.7
29	43.8	37.2–47.9	42.0	37.5–43.8	38.5	36.7–38.9	41.8	39.2–46.2	43.0	46.1–51.0	47.2	42.0	43.6
43	67.2	64.2–70.3	71.2	64.5–80.8	49.5	45.0–49.5	55.0	53.5–62.0	71.2	70.0–72.3	74.0	71.2	67.2
57	78.5	67.5–83.0	93.0	80.0–103.0	61.0	53.0–67 0	71.0	70.0–87.0	97.5	95.3–99.8	101.5	93.0	78.5
71	92.3	39.5–99.0	115.5	94.5–161.5	70 0	63.0–78.0	99.0	87.0–104.0	114 0	111.0–117.0	111.0	111.0	92.3

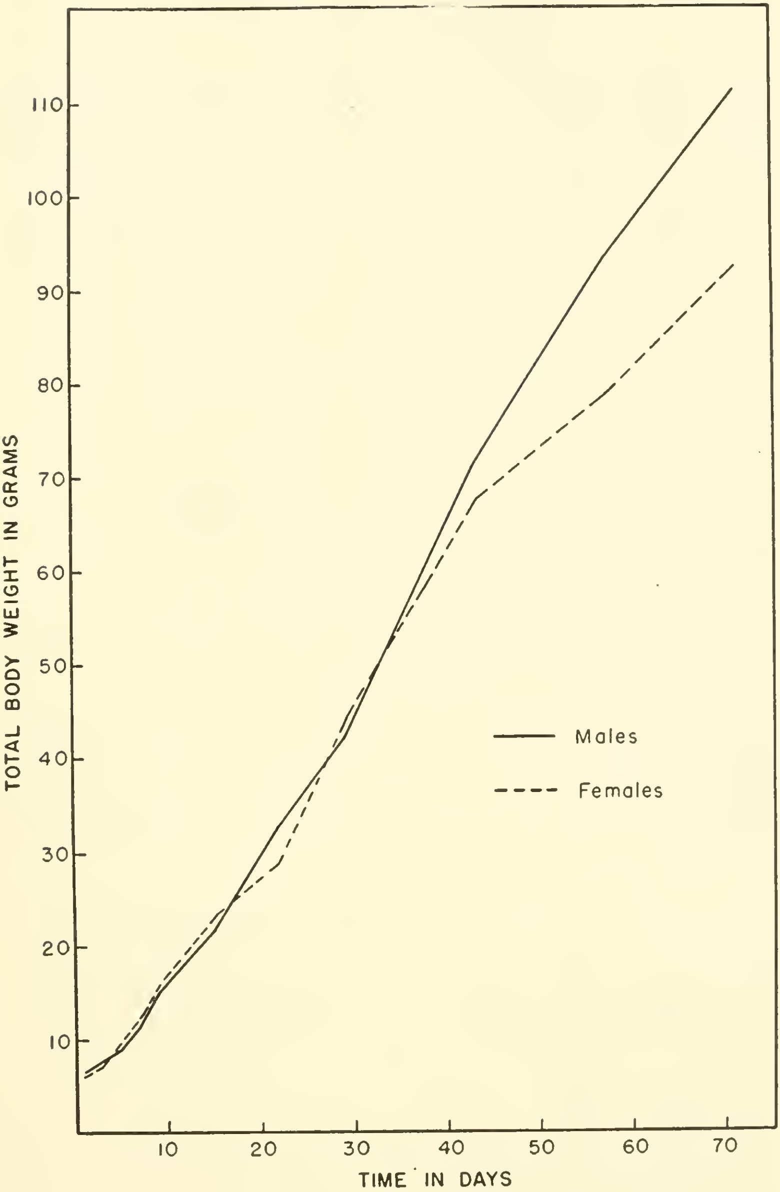

FIG. 1. Growth rates of 12 female and 11 male *Sigmodon* from birth to the age of sexual maturity.

RADIOLOGICAL METHODS

MATERIALS AND METHODS

The radioactive phosphorus used in this study was purchased from Abbott Laboratories, North Chicago, Illinois. They receive P^{32} from the Isotopes Branch of the Atomic Energy Commission as a solution of approximately carrier-free H_3PO_4 (radioactive) in dilute HCl. Abbott further prepares the isotope by adding one ml. of 0.1 per cent Na_2HPO_4 to each 30 to 35 ml. of the solution. To this solution NaCl is added in a quantity just less than the amount required to make the solution isotonic in the absence of other sodium ions; crystals of $NaHCO_3$ are added in small amounts until the pH is adjusted to 5.5 to 6.5. We received the solution of isotope from the Abbott Laboratories after it had been processed in this manner.

A non-radioactive solution containing 1.0 per cent Na_2HPO_4 and 0.9 per cent NaCl, adjusted with 5.0 per cent $NaHCO_3$ and N/10 HCl to a pH of 5.5 to 6.5, was prepared and used to dilute the radioactive material as necessary in the experimental work. A non-radioactive solution of phosphate-saline was used for injection into control animals. Injections were adjusted so that experimental animals and their corresponding controls received approximately equal concentrations and volumes of salt solutions.

Control and radioactive solutions were administered intraperitoneally. Animals were held by an attendant, with their heads down so that the organs of the abdominal cavity were in a forward position, in order to avoid injecting the solution directly into one of the abdominal organs.

A Tracerlab "64" Scaler (Model SC-2A Scaler) was used to measure radioactivity of the solution to be injected and to measure radioactivity retained in various tissues of the sacrificed animals. A P^{32} standard obtained from the United States Bureau of Standards was used to standardize the counter. Background counts and standardization of the scaler were made at least once each day that it was used.

A Tracerlab laboratory monitor (Model SU-3A) was used to detect contaminated areas in the laboratory, and to determine the distance at which control animals were safe from the effects of radiation from treated animals. A constant check for background fluctuations was made with the monitor when the Scaler was used over a long period of time. When a change in background count was noted on the monitor the background count was retaken with the scaler.

DETERMINATION OF LD50/30-DAY DOSE OF P^{32}

Injection levels for eight groups of experimental animals are shown in table 6. Groups I and II, the first animals injected with P^{32} in our laboratory, were used to obtain some understanding of the effects of radiation on these animals. Group III is comprised of seven pairs of animals which were taken from the breeding stock and injected with amounts of P^{32} varying from 0.1 microcuries to 4.0 microcuries per gram of body weight. This group was used in a study of the effects of P^{32} on reproduction. Groups IV, V, VI, and VII were used in a study to establish the LD50/30-days dosage. Group VIII was injected with the LD50/30-days dosage and comprises the main group used in the tissue studies.

Experiments to establish the LD50/30-days dosage for P^{32} in *Sigmodon* was carried out with the results indicated in table 7. There were no deaths in animals injected with 4.0 microcuries per gram of body weight. The animals went through a period in which they did not respond normally to handling and feeding but all recovered by the end of the 30-day period. Abnormal response in the injected animals was characterized by fast breathing, a more rapid heart beat and a highly excitable state of being. Animals which had been easy to handle were now disturbed by every movement about them. Animals injected with 4.2 microcuries per gram of body weight went through this same period of stress with 28.6 per cent mortality in 15 days. The animals still living at the end of 30 days seemed to be completely recovered. The group injected

TABLE 6

Levels of Injection of P^{32} in *Sigmodon*

Group	Number of animals	Sex	Amount of P^{32} injected
I	13	7M & 6F	50 μc per animal
II	6	6F	200 μc per animal
III	14	7M & 7F	10 μc–70 μc per animal
IV	6	3M & 3F	4.0 μc/gm wt.
V	5	2M & 3F	5.0 μc/gm wt.
VI	6	3M & 3F	4.4 μc/gm wt.
VII	7	4M & 3F	4.2 μc/gm wt.
VIII	57	57M	4.3 μc/gm wt.
Controls	50	25M & 25F	
Total	164		

TABLE 7

Determination of LD50/30-days Dosage of P^{32} for *Sigmodon hispidus*

Amt. of P^{32} injected in microcuries/gm wt.	No. animals injected	No. of deaths	% of deaths	Occurrence of death days after injection
4.0	6	0	0.0	
4.2	7	2	28.6	11, 15
4.4	6	4	66.7	8, 9, 9, 14
5.0	5	4	80.0	10, 14, 14, 19
4.3	30	18	60.0	8–(1 animal) 9–(1 animal) 10–(2 animals) 11–(1 animal) 12–(1 animal) 13–(3 animals) 14–(1 animal) 17–(2 animals) 18–(3 animals) 20–(1 animal) 21–(1 animal) 22–(1 animal)

with 4.4 microcuries per gram of body weight showed the effects more severely, with 66.7 per cent mortality. Again, however, the two animals which remained alive at the end of 30 days seemed to be in normal health. The group which was injected with 5.0 microcuries per gram of body weight showed 80 per cent mortality with only one survivor, but at the end of 30 days it seemed fully recovered.

When death came it was sudden in most cases. Irradiated animals seemed to be in severe pain and died in a state of violent agitation. They bit into the wire mesh covering the cage and the teeth of several had to be forced free from the mesh after death. Gross examination showed signs of anoxia. None of the animals which died was used for microscopic studies of the tissues.

From the data recorded in table 7 the LD50/30-days dosage was estimated to be slightly less than 4.3 microcuries per gram of body weight. This amount, 4.3 microcuries per gram of body weight, was used in a later group in which studies of organs were made. Mortality in this group was 60 per cent; 18 of the 30 injected animals died within 22 days.

RELATIVE RADIOACTIVITY OF THE ORGANS

Animals from groups I and VIII, shown in table 6, were sacrificed at intervals ranging from one-fourth day to sixty-three days following injection of P^{32}. Radioactivity of several organs was measured in counts per minute then converted to, and recorded as, microcuries per gram of organ. Organs were removed from pithed rats and immediately weighed and placed in fixative in small individual Stender dishes. The amount of fixative used was just enough to cover the organ. Counts were then made by placing the dish containing the tissue under the Geiger tube. A lead shield, two millimeters in thickness, enclosed the Geiger tube and extended down over the top of the Stender dish.

Since the organs were to be used in a microscopic study they were not ground and dried before counts were made. The counts actually are surface counts and are subject to error from secondary absorption in the surface of the organ and secondary scattering from the Stender dish. Disintegrations occurring in the lower central portions of the organ would have, in addition, irregular patterns of penetration and would introduce still other errors when counted. Keeping in mind that radiations from P^{32} will normally penetrate tissue only two to four millimeters, with seven millimeters of tissue the extreme limit, all pieces of organs to be counted were cut in pieces of five millimeters, or less, in thickness. Pieces from larger organs, such as the liver, were cut to expose a surface nearly the same size as that of the smaller organs, such as the kidney and testis. The counts were therefore taken from the radiations being emitted from the surface of whole organs in case of the spleen, thymus and lymph node; from the surface of sectioned halves of testis and kidney; and from the surface of cut pieces of bone, liver, duodenum and stomach. It should be stressed again that the technique employed in preparing and counting the tissues had many inherent errors. No attempts were made to account for all of the radioactivity in the organs.

The relative radioactivity of several organs from 13 animals under the conditions stated are given in table 8. These rats were injected with 1.1 microcuries of radioactive phosphorus per gram of tissue (approximately 50 microcuries of radioactive phosphorus per animal) in order to determine the effects of low levels of P^{32}. They were sacrificed at irregular intervals, beginning with one animal on the first day following the day of injection and extending through 63 days. The rate of decrease in activity for a given organ is not uniform in all cases but is represented by smoothed curves (see fig. 2) which resembles the normal disintegration curve of radioactive phosphorus.

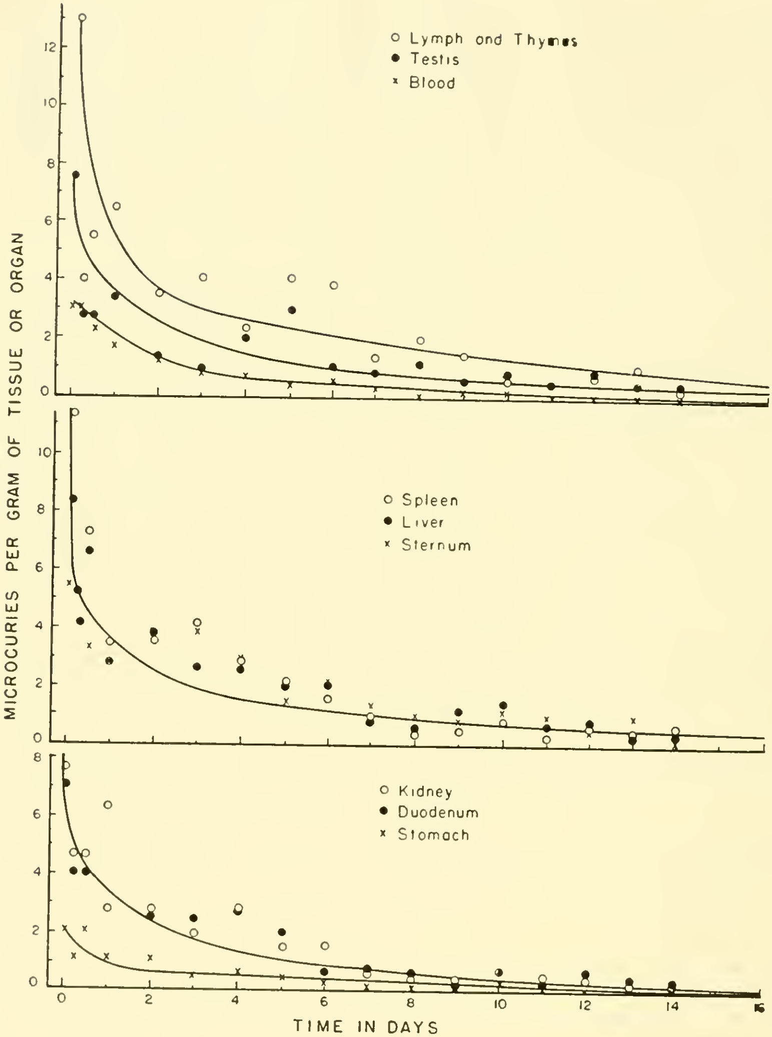

FIG. 2. Relative concentration of P^{32} in tissues and organs of rats that received 1.1 microcuries per gram of body weight, and rate of loss through 16 days following treatment.

A second group of 20 animals (table 9), was injected with 4.3 microcuries per gram of body weight. Animals were sacrificed at intervals of six hours in the first day; at intervals of one day for 14 days following the injections; and at each of the first three half-life intervals of the P^{32}. The results obtained from this group were also calculated in terms of microcuries of P^{32} per gram of organ.

TABLE 8

Radioactivity of some of the organs of *Sigmodon* at various intervals after the animals have been injected with 50 microcuries of P^{32} per animal. Numbers represent microcuries per gram of organ.

Animal	2077	2076	2087	2086	2084	2089	2088	2083	2081	2082	2080	2079	2078
Days following injection	1	3	5	7	10	12	14	17	19	21	35	49	63
Animal surface	3.3	3.8	4.6	2.8	1.8	3.2	2.6	2.1	1.5	1.3	0.2	0.1	0.2
Blood	1.0	1.1	1.4	0.3	0.3	0.5	0.2	0.2	0.1	0.1	0.0	0.0	0.0
Heart	1.4	1.2	3.1	0.9	0.9	2.7	0.5	0.5	0.4	0.2	0.1	0.0	0.0
Liver	1.7	1.2	0.9	0.3	0.4	1.0	0.4	0.3	0.3	0.1	0.1	0.0	0.0
Spleen	2.7	2.2	1.6	2.8	4.2	2.0	0.9	2.1	1.2	0.6	0.0	0.1	0.1
Testis	2.4	1.2	1.8	1.4	1.3	1.1	0.8	0.7	0.4	0.2	0.0	0.0	0.0
Bones	3.9	5.7	4.8	3.9	2.7	5.0	5.6	3.3	2.8	1.9	0.5	0.2	0.0
Kidneys	0.9	2.2	1.5	0.8	0.9	0.8	0.7	0.4	0.3	0.1	0.0	0.0	0.0
Muscle	0.0	1.2	1.5	0.4	1.0	1.3	0.6	0.4	0.3	0.1	0.0	0.0	0.0

TABLE 9

Radioactivity of some of the organs of *Sigmodon* at various intervals after the animals have been injected with 4.3 microcuries of P^{32} per gram of body weight. Numbers represent microcuries per gram of organ.

Animal	P-1	P-2	P-3	P-4	P-5	P-6	P-7	P-8	P-9	P-10	P-11	P-12	P-13	P-14	P-15	P-16	P-17	P-18	P-19	P-20
Days following injection	1/8	1/4	1/2	1	2	3	4	5	6	7	8	9	10	11	12	13	14	14.3	28.6	42.9
Bone	5.7	4.2	3.4	2.8	3.8	3.8	3.0	1.5	2.3	1.4	1.0	0.8	1.3	1.0	0.5	1.0	0.2	0.3	0.2	0.0
Spleen	11.3	4.2	7.3	3.5	3.6	4.2	2.9	2.2	1.6	1.0	0.4	0.5	0.8	0.3	0.7	0.5	0.7	0.6	0.1	0.0
Liver	8.4	5.3	6.6	2.8	3.8	2.6	2.6	2.1	2.1	0.8	0.6	1.2	1.5	0.7	0.8	0.4	0.4	0.5	0.1	0.0
Blood	3.1	3.0	2.3	1.7	1.3	0.8	0.7	0.4	0.6	0.3	0.1	0.3	0.3	0.1	0.1	0.1	0.1	0.1	0.0	0.0
Thymus and Lymph	13.0	4.9	5.5	6.5	3.5	4.1	2.3	4.1	3.9	1.4	2.0	1.5	0.6	0.5	0.8	1.1	0.4	0.4	0.1	0.0
Testis	7.6	2.8	2.0	3.4	1.4	1.0	2.0	3.0	1.1	0.9	1.2	0.6	0.9	0.5	0.9	0.5	0.5	0.6	0.1	0.0
Kidney	7.7	4.7	4.7	2.8	2.8	2.0	2.4	1.5	1.6	0.7	0.5	0.5	0.8	0.6	0.6	0.3	0.3	0.4	0.1	0.0
Duodenum	7.1	4.0	4.0	6.4	2.6	2.5	3.3	2.1	0.7	0.8	0.7	0.4	0.8	0.3	0.7	0.5	0.4	0.3	0.1	0.0
Stomach	2.1	1.2	2.1	1.2	1.2	0.6	0.7	0.5	0.3	0.2	0.1	0.2	0.4	0.2	0.2	0.1	0.1	0.1	0.0	0.0

Animals injected with 4.3 microcuries per gram of body weight (table 9) received from 300 to 400 microcuries per animal. The animals in group VIII (table 9) were therefore injected with approximately four times the amount of radioactive phosphorus per gram of organ compared with those represented in table 8. It is obvious that metabolism of the phosphorus is not proportional to the amount available. After 24 hours the organs of the animals receiving 300 to 400 microcuries had approximately the same activity as did the organs of the animals that had received only about 50 microcuries.

The greatest amount of retained P^{32} is found in the blood-forming tissues and in the bones. The testis and duodenum are highly radioactive during the first 24 hours but the amount of phosphorus drops off quickly after this initial acquisition. The amount of radioactive phosphorus in the blood and in the stomach is much lower from the onset than that in other organs of the body. The small amount of radioactive phosphorus in the blood supports the contention that direct effects of radioactivity on the blood are not so great as indirect effects, acting upon the blood-forming organs.

EFFECTS OF IRRADIATION ON BLOOD CELLS

Materials and Methods

In this investigation, six characteristics of the blood were observed, including (1) erythrocyte volume; (2) sedimentation rate; (3) haemoglobin; (4) total erythrocytes; (5) total leucocytes and (6) differential leucocyte counts.

Blood was taken by cardiac puncture from the animals under condition of primary ether-anesthesia. Micro-analytical equipment, requiring approximately 0.25 ml. of blood to run the six desired tests, was used. A two ml. hypodermic syringe and a one-half inch 23-gauge needle were used for taking blood. Techniques insuring asepsis were used in preparing all equipment and animals with the result that blood could be taken from an animal as often as once a week without causing any noticeable effects on its health. All control animals were healthy 30 days after the conclusion of the experiments.

A solution of heparin (1 ml. of heparin to 99 ml. of distilled water) was drawn into the needle and syringe and expelled before the needle was inserted into the heart. Blood from the syringe was then placed in a spot dish previously cleaned with the heparin solution. The use of heparin prevented coagulation of the blood while the tests were being set up. Care was taken not to introduce

TABLE 10

Normal Blood Values for *Sigmodon*

Age in mos.	Number of animals	Animal weight, grams	Erythrocyte volume, %	Sedimentation rate, mm/hr.	Haemoglobin, gms./100 cc	Total erythrocyte, millions	Total leucocyte, thousands	Differential leucocyte count				
								Neutrophils, %	Eosinophils, %	Basophils, %	Lymphocytes, %	Monocytes, %
2	18	(range) 51.0–100.0 (median) 71.5	30–45 38	1.1–3.0 2.0	14.0–17.0 15.5	6.31–8.79 7.51	5.0–10.7 6.85	5–27 13	0–0 0	0–0 0	70–92 84	0–5 3
3	10	(range) 51.1–152.1 (median) 122.5	26–48 36	1.2–2.0 2.0	11.5–16.5 14.0	5.92–8.61 6.92	4.1–11.5 8.15	6–45 30	0–0 0	0–1 0	50–90 65	0–8 5
5	7	(range) 120.0–183.1 (median) 131.0	25–40 35	1.0–2.0 1.2	12.5–15.0 14.5	5.76–6.99 6.57	4.8–10.88 8.65	23–60 40	0–1 0	0–1 0	33–76 56	1–8 4
7–10	10	(range) 106.4–313.0 (median) 201.5	28–41 34	1.0–1.9 1.0	14.0–16.5 14.5	6.15–7.8 7.52	4.04–7.8 6.07	7–58 17	0–2 0	0–0 0	32–89 79	2–9 4
2–16	46	(range) 51.0–313.0 (median) 126.8	25–48 35.5	1.0–3.0 1.6	11.5–17.0 14.3	5.76–8.79 7.21	4.04–11.5 7.5	5–60 25	0–2 0	0–1 0	32–92 71	0–9 4
Nature	20	(range) 62.2–202.9 (median) 101.4	24–44 36	1.0–2.3 1.6	11.0–16.5 14.3	5.69–7.79 7.17	4.75–11.7 7.82	20–46 25	0–2 0	0–2 0	49–77 72	0–10 3

a dilution factor with the heparin solution. In a few cases no heparin was used; these determinations resulted in the same findings but only after great difficulty caused by coagulation of the blood.

Determination of the erythrocyte volume was made by using a Van Allen hematocrit; sedimentation rate was obtained by using a Landau-Adams Microsedimentation Pipette; and percentage of haemoglobin was determined by using a Spencer Hemoglobinometer. Total counts of erythrocytes and leucocytes were made with a Spencer Bright-Line Haemacytometer by following the conventional procedure.

Differential counts were made from smears prepared in the usual manner, and stained with Wright's blood stain.

TABLE 11

Comparative Normal Blood Values for *Sigmodon*, *Rattus* and *Mus*

	Mus musculus	*Rattus norvegicus*	*Sigmodon hispidus*
Erythrocyte volume (percent)	....	50	24–48
Sedimentation rate (mm./hr.)	....	1.2	1.0–3.0
Haemoglobin (gms./100cc.)	15.6	15.6	11.0–17.0
Total Erythrocytes (millions)	8–11	7–10	5.69–8.79
Total Leukocytes (thousands)	3–22	6–18	4.04–11.70
Differential Leukocytes			
Neutrophils (percent)	8–25	8–39	5–60
Eosinophils (percent)	0–4	0–4	0–2
Basophils (percent)	0–0	0–0	0–2
Lymphocytes (percent)	63–80	55–96	32–92
Monocytes (percent)	8–14	0–3	0–10

NORMAL BLOOD VALUES

Normal values for the characteristics under observation (previously unavailable), obtained from 65 untreated animals are summarized in table 10. Data are presented for animals in four age groups as follows: two months, three months, five months, and 7 to 16 months. Also, data on all laboratory-reared rats (2-16 months) are summarized. Values obtained from 20 wild *Sigmodon* of varying ages, are given for comparison with the data from the laboratory-reared animals. All rats seemed to be healthy. No significant difference was found between the values for males and females; therefore the results obtained from both sexes are tabulated together. Laboratory-reared animals were all first generation laboratory-born. Results of this study are judged to show the normal values for the several characteristics of the blood of the native cotton rat, *Sigmodon hispidus texianus.* Comparison of the 45 laboratory-reared animals with the 20 taken from nature revealed no significant differences.

Blood values obtained for the cotton rat compared favorably with those of the laboratory rat, *Rattus norvegicus* (Kolmer and Boerner, 1945:52, and Creskoff, *et. al.*, 1949:406-412), and with the laboratory mouse, *Mus musculus* (Fekete, 1941:93), as shown in table 11.

BLOOD VALUES FROM IRRADIATED ANIMALS

The effects of irradiation with radioactive phosphorus (P^{32}) on the formed elements of the blood of the cotton rat were observed in four groups of animals. Each group was injected with a different amount of P^{32} so that effects at different levels could be observed. The first group, consisting of 13 experimental, and 12 control, animals, was injected with 1.1 microcuries per gram of body weight (approximately 50 microcuries per animal). Experimental and control animals were litter mates selected at random from four litters. Since normal blood values were previously found to vary significantly from one group of animals to another, it seemed necessary to have controls which were litter mates with the experimental animals. None of the injected animals of this group died during the nineteen days in which they were observed. The total leucocyte count dropped appreciably but the erythrocyte count did not drop below the lower levels of the normal range. By the nineteenth day the red count was near the middle of the normal range and the total white count was approaching the normal. Table 12 gives a summary of the effects of the injection on the characteristics of the blood under observation. The median values obtained from 13 injected animals are recorded for one, three, five, twelve and nineteen days following the day of injection. The range of values obtained from the 12 control animals, as observed on the same days, is also given. Animals of this group gained an average of 1.7 grams per day in total body weight.

The second group of animals, litter mates from two litters, was injected with 4.0 microcuries per gram of body weight. None of the animals treated with P^{32} died during the 32 days in which data were collected. The drop in white cell count which was observed in the first group was again noted with the lowest count appearing on the fourteenth day, followed by a gradual rise in the total number of leucocytes. The total erythrocyte count was also greatly affected. The red-cell count fell to slightly less than one-half the normal count by the fourteenth day, and was followed by a rapid rise. Table 12 gives the median values obtained for the six characteristics of the blood on the third, fourteenth, twenty-first, twenty-eighth and thirty-second day following the injection of P^{32}. The sedimentation rate, erythrocyte volume and haemoglobin fell during the first fourteen days and then rose to normal along with the total red-cell count. Animals of this group gained an average of 1.4 grams per day. The range of values obtained from the control animals, as observed on the same days, is also given in table 12.

The results obtained from the third group of animals injected with 5.0 microcuries per gram of body weight are shown in table 12. This amount is 0.7 microcuries per gram of body weight in excess of the LD50/30-days dosage. Death of 80 per cent of the animals by the fourteenth day prevented information being obtained after that time. Litter mates from two litters were selected, five animals as controls and five animals for the experimental group. The total white cell-count was lowest at seven days and showed only an insignificant rise by the fourteenth day. Total red cell count fell less rapidly but on the fourteenth day was 62 per cent below the normal average. Erythrocyte volume and percentage of haemoglobin both fell about fifty per cent during the 14 days following the injection of P^{32}. Sedimentation rate rose rapidly and did not show the initial fall as in the two previous groups. The sedimentation rate on the fourteenth day was 225 per cent as compared to the normal. In this group the average body weight increased only 0.29 grams per day as compared to 1.5 grams per day for the controls. The range of the control animals, as observed on the same days, is also given.

The fourth group of animals used for studies of the blood were injected with 4.3 microcuries of P^{32} per gram of body weight (the estimated LD50/30-days dosage). Results obtained from 18 experi-

TABLE 12

Characteristics of the Blood of *Sigmodon hispidus* at various intervals following the intraperitoneal injection of different amounts of P^{32}

Days after injection	Animal weight, gms.	Erythrocyte volume, %	Sedimentation rate, mm./hr.	Haemoglobin, gms./100 cc	Total erythrocyte, millions	Total leucocyte, thousands	Differential leucocyte count				
							Neutrophils, %	Eosinophils, %	Basophils, %	Lymphocytes, %	Monocytes, %
Dose: 1.1 μc/gm. body wgt. median values from 13 animals.											
0	73.0	35	1.5	14.5	7.70	7.50	24	1	0	71	4
1	81.5	33	1.3	15.5	7.73	4.48	7	0	0	87	4
3	90.5	33	1.7	15.5	7.00	4.60	10	0	0	89	1
5	97.5	36	1.0	16.0	7.00	4.48	7	0	0	92	1
12	103.5	36	1.0	16.0	6.50	2.75	7	0	0	92	1
19	105.0	40	1.0	16.5	7.00	3.55	22	1	1	73	3
Range obtained from 12 control animals.											
	71.0-99.0	33-40	1.0-1.7	14.0-16.0	7.00-8.20	6.50-7.90	18-26	0-1	0-1	66-78	1-5
Dose: 4.0 μc/gm. body wgt. median values from 6 animals.											
0	74	37.5	1.9	15.0	7.60	8.30	23	0	0	75	2
3	77	35.0	1.8	14.7	6.08	3.25	13	0	0	85	2
14	93	26.0	1.4	11.0	3.67	2.20	3	0	0	95	2
21	99	39.0	1.7	14.0	6.10	2.37	8	0	0	90	2
28	109	38.0	2.0	15.5	6.10	2.40	15	0	0	83	2
32	119	39.0	2.6	15.0	6.18	3.48	19	0	0	79	2
Range obtained from 6 control animals.											
	69.5-98.0	37.0-44.0	1.6-2.5	14.8-17.5	6.87-7.93	7.0-9.0	16-25	0-1	0-0	74-81	1-4
Dose: 5.0 μc/gm. body wgt. median values from 5 animals.											
0	75	42.0	2.0	16.0	7.59	6.80	12	0	0	85	3
7	79	37.0	2.6	15.5	6.17	1.90	4	0	0	92	4
14	79	20.0	4.5	9.0	2.83	1.95	5	0	0	92	3
Range obtained from 5 control animals.											
	53-75	32.0-42.0	1.5-2.0	14.5-16.0	7.34-7.59	5.10-6.80	12-18	0-0	0-0	79-85	2-4

TABLE 13

Characteristics of the Blood of *Sigmodon hispidus* at various intervals following the intraperitoneal injection of 4.3 μc of P^{32}/gm. body wgt.

Days after injection	Animal weight, gms.	Erythrocyte volume, %	Sedimentation rate, mm./hr.	Haemoglobin, gms./100 cc	Total erythrocyte, millions	Total leucocyte, thousands	Differential leucocyte count				
							Neutrophils, %	Eosinophils, %	Basophils, %	Lymphocytes, %	Monocytes, %
Median values obtained from 18 animals											
0	72	37.0	1.9	15.0	7.52	7.50	23	0	0	74	3
1/4	72	37.0	1.9	15.2	7.61	7.25	24	0	0	72	4
1/2	72	37.0	1.9	15.0	7.50	6.50	22	0	0	75	3
3/4	72	36.0	1.9	14.7	7.35	5.65	19	0	0	76	5
1	72	37.0	1.8	14.8	7.20	4.00	19	0	0	77	4
2	73	36.0	1.8	14.8	6.79	3.55	14	0	0	82	4
3	75	35.0	1.8	14.6	6.01	3.15	12	0	0	84	4
4	75	33.0	1.8	14.5	6.00	3.00	8	0	0	89	3
5	77	33.0	1.8	14.6	6.01	2.85	9	0	0	86	5
6	76	32.0	1.6	14.4	5.90	2.60	7	0	0	89	4
7	77	32.0	1.6	14.3	5.90	2.40	5	0	0	91	4
8	79	30.0	1.6	14.3	5.75	2.39	5	0	0	91	4
9	81	27.0	1.5	14.0	5.20	2.40	4	0	0	91	5
10	81	27.0	1.5	13.7	4.62	2.35	4	0	0	93	3
11	81	25.0	1.4	13.8	4.58	2.35	5	0	0	91	4
12	82	26.0	1.4	12.0	4.20	2.20	6	0	0	91	3
13	82	25.0	1.4	11.0	3.61	2.10	5	0	0	92	3
14	84	23.0	1.4	10.3	3.12	2.05	4	0	0	93	3
28	93	24.0	1.8	14.7	6.20	2.20	9	0	0	87	4
Range obtained from 12 control animals.											
		35–40	1.5–2.0	14.0–15.5	6.90–8.20	5.50–8.00	16–27	0–0	0–0	69–80	3–5

mental animals and 12 control animals are given in table 13. Litter mates from six litters were used for experimental and control animals. Frequent observations were made on this group so that the time of the several changes could be more accurately observed. The lowest total white cell count and lowest total red cell count were observed on the fourteenth day. Erythrocyte volume, sedimentation rate and per cent of haemoglobin all fell significantly and were at their lowest on the fourteenth day. The average gain in body weight was 0.7 grams per day. Data obtained from control animals, as observed on the same days, are also given.

In all four groups the white cells were found to be affected earlier and more seriously than the red cells. The differential leucocyte counts are given for each group in tables 12 and 13. Changes in total white cell count for each of the four groups of experimental animals are shown graphically in Figure 3. Changes in per cent of lymphocytes and neutrophils are shown in Figure 4. In each group the results are similar but greater changes occurred in the animals that were given larger injections. The percentage of lymphocytes abruptly increased above the normal range and, after a time, returned to or toward normal, depending upon the amount of P^{32} which was administered. In contrast, the percentage of neutrophils abruptly decreased below the normal range, and then slowly returned to or toward normal.

Comparison of the effect of the various injections on the number of erythrocytes is shown graphically in Figure 5. The lowest red cell count was observed on the fourteenth day following the injection of P^{32} in all groups. The recovery of the red cell count may be observed on the same figure. The percentage of haemoglobin is shown graphically on Figure 6. Its fluctuations followed closely the pattern of the total red cell count. Changes in erythrocyte volume (Figure 7) also closely followed the pattern of the total red cell count. The sedimentation rate is given graphically in Figure 8. Here the pattern of the total red cell count is not so closely followed and in Figure 8-D it can be seen that a sharp increase in sedimentation rate occurred in those animals injected with 5.0 microcuries per gram of body weight.

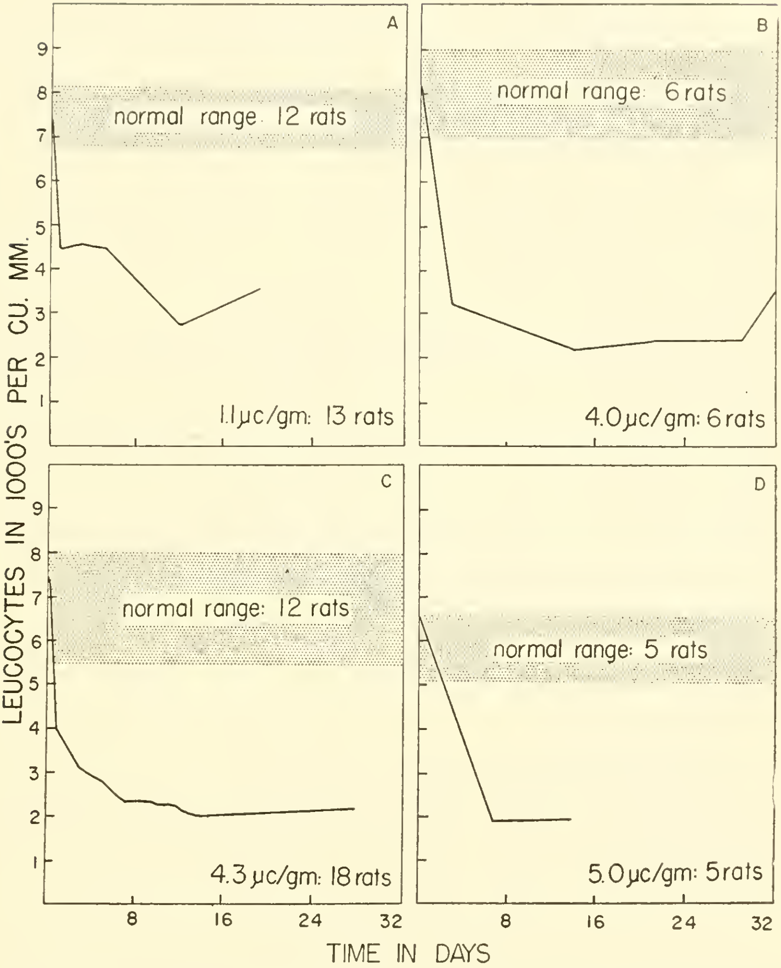

Fig. 3. Effect of dosage of P^{32} on total leucocyte counts in four groups of animals. Shaded bar shows normal range of leucocyte counts before treatment.

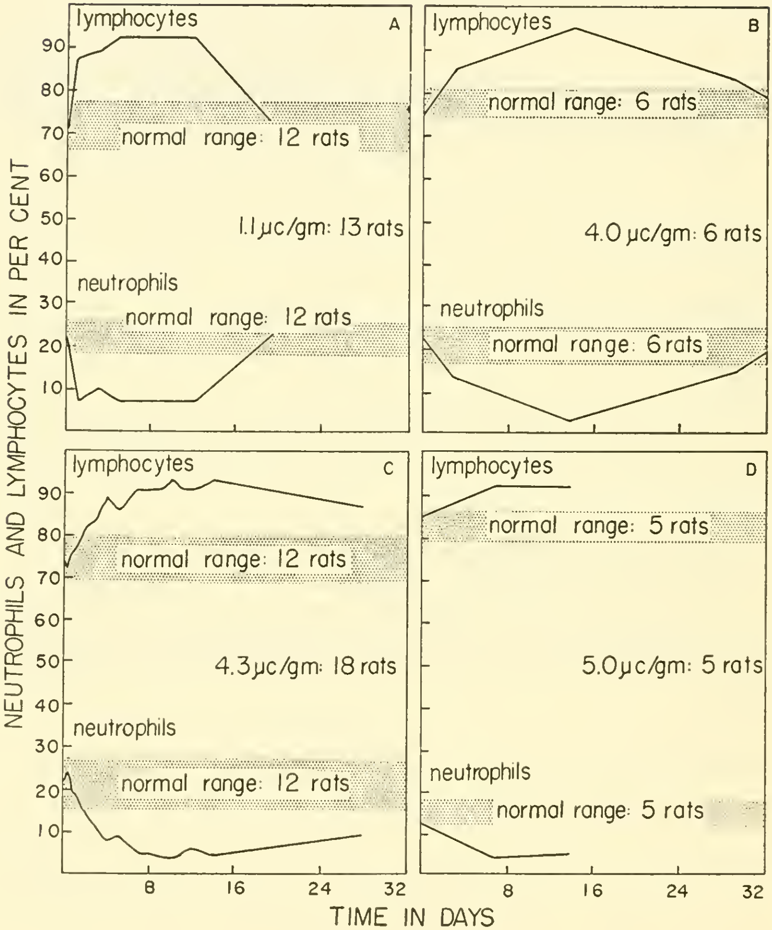

FIG. 4. Effect of dosage of P^{32} on total numbers of neutrophiles and lymphocytes in four groups of animals. Shaded bar shows normal range of counts before treatment.

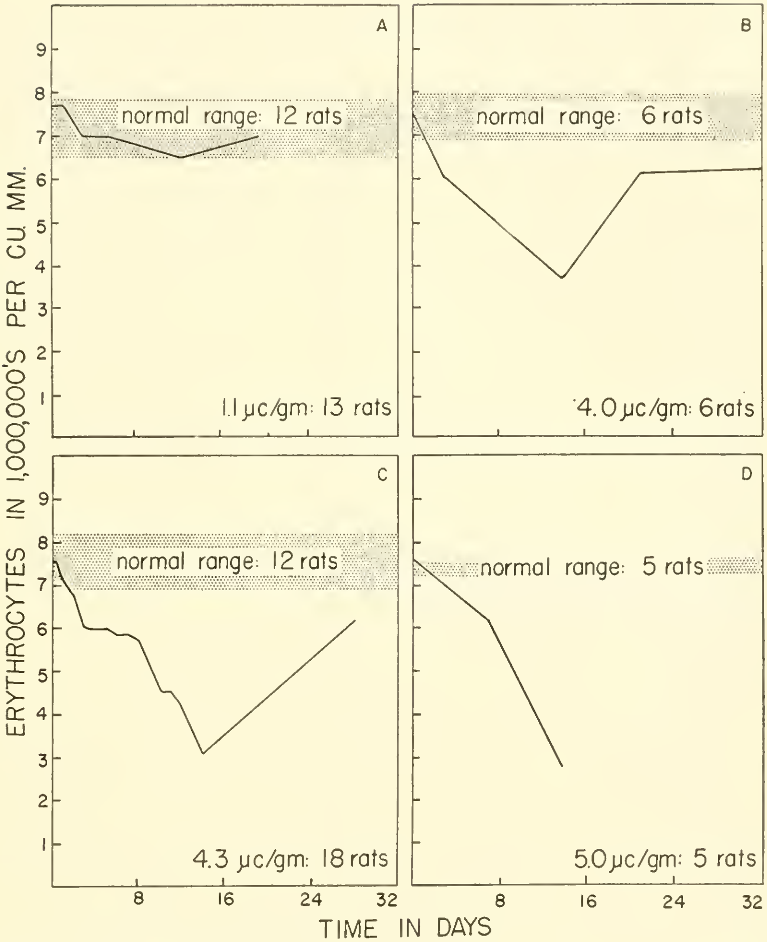

FIG. 5. Effect of dosage of P^{32} on numbers of erythrocytes in four groups of animals. Shaded bar shows normal range of counts before treatment.

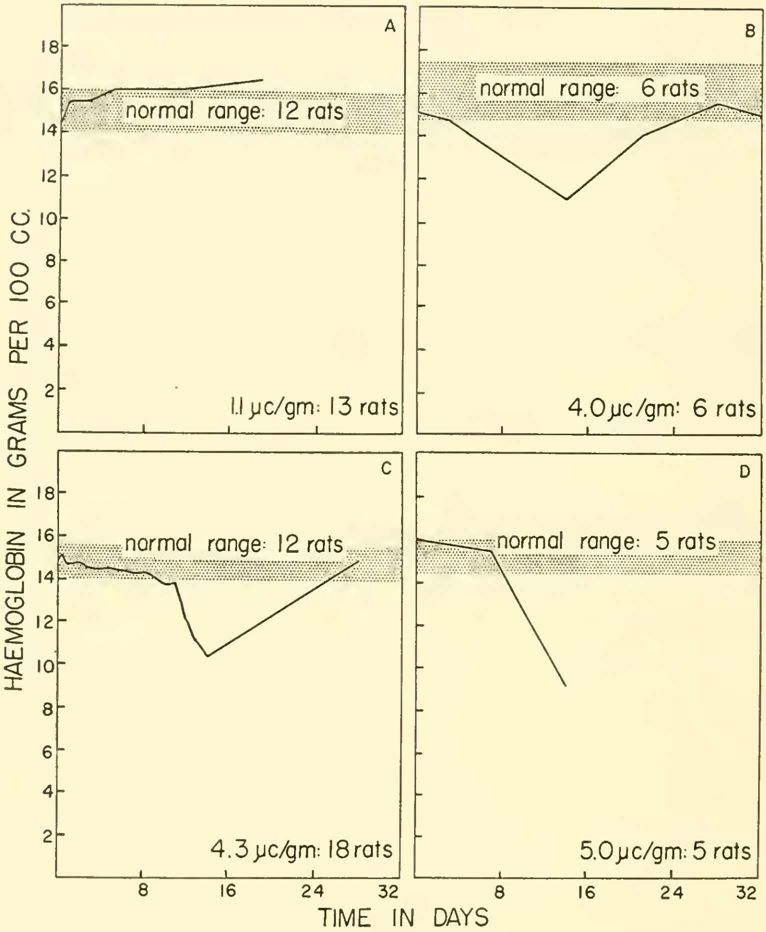

Fig. 6. Effect of P^{32} on amount of hemoglobin in the blood of four groups of animals. Shaded bar shows normal range of amounts of hemoglobin before treatment.

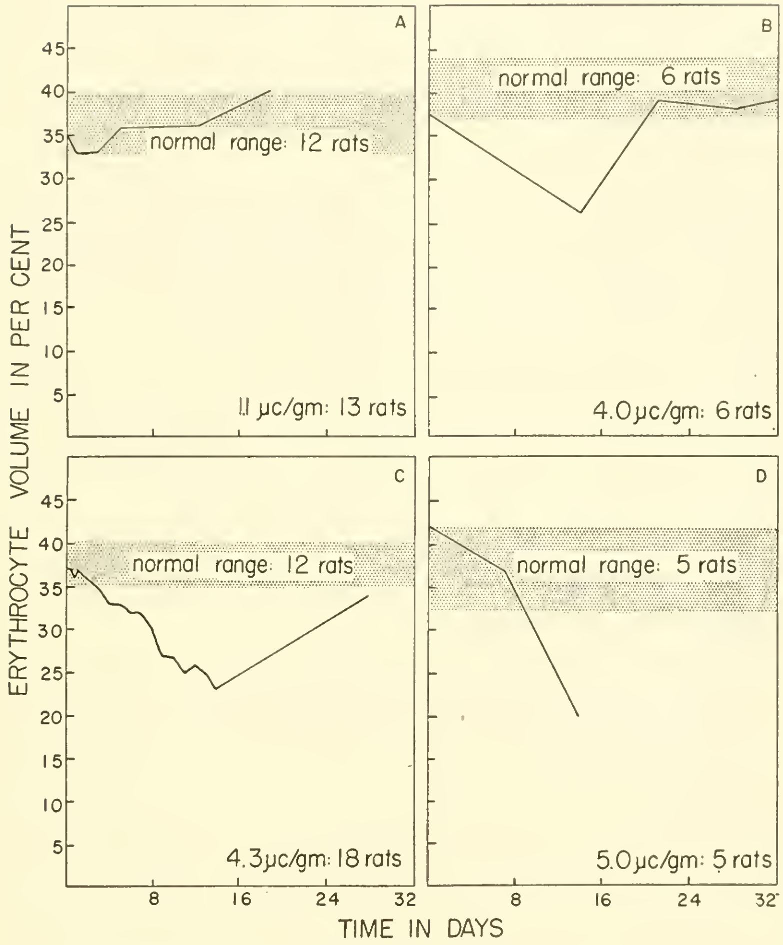

FIG. 7. Effect of dosage of P^{32} on erythrocyte volume in four groups of animals. Shaded bar shows normal range of values before treatment.

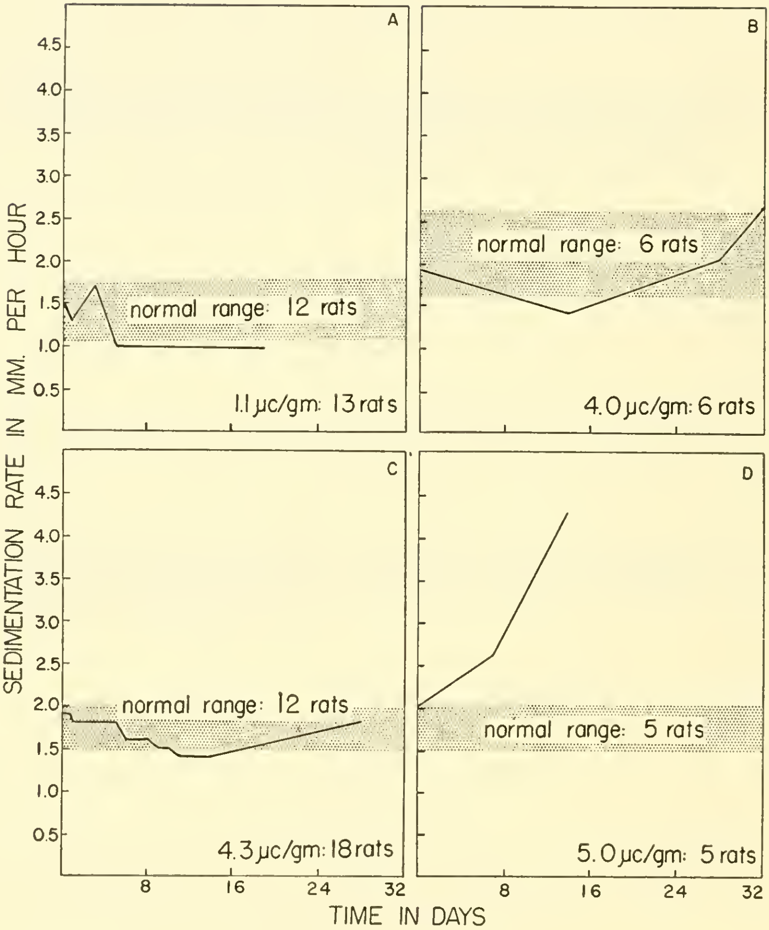

FIG. 8. Effect of dosage of P^{32} on sedimentation rate in four groups of animals. Shaded bar shows normal range of values before treatment.

SUMMARY

The cotton rat, *Sigmodon hispidus,* has proven to be a valuable addition to the usual experimental animals of the laboratory. Its response to irradiation from intraperitoneal injections of radioactive phosphorus (P^{32}) is not markedly different from that expressed in other animals.

The cotton rat can be reared in the laboratory and quickly adapts itself to laboratory conditions. With controlled temperatures ranging between 70° F. to 80° F., reproduction continues throughout the year with litters born at average intervals of 32.7 days. The average number of young per litter is 5.2.

Newly-born young can be handled without adverse effects upon them, and mothers will continue to care for their young after such handling. There is little difference in the weight of males and females at birth. The rate of gain in weight in both sexes runs parallel up to the approximate age of 35 days when the males begin to increase in weight more rapidly than the females; the males continue to increase at a more rapid rate. Year-old laboratory-reared females weigh 240 to 260 grams and males 275 to 300 grams.

The average age at sexual maturity is two and one-half months. Females can be housed together but males are incompatible unless they have been together from birth or shortly thereafter. A male can be left with its mate without harm to the young. Reproduction is enhanced by taking advantage of the post-parturition estrus. Occasional incompatibility between males and females occurs following parturition but this is infrequent and does not cause any serious problem.

The normal blood-values for the six constituents studied compare favorably with those reported for the laboratory rat and the laboratory mouse.

No significant differences in blood values were found between males and females, nor between first generation laboratory-reared animals and wild animals obtained by trapping.

The effects of irradiation on the blood of the cotton rat are similar to those reported for other animals. A combination of direct and indirect effects on the formed elements of the blood was observed. A drop in total white cells was noted within the first 24 hours following the injection of P^{32}. The total red cell count dropped significantly on the second day following the injection. The fourteenth

day, or approximately the time of the first half-life of the P^{32}, was marked by the lowest level of both total red and white counts.

No serious effects seemed to be caused by the drop of total white cell count. Drop in the total red cell count, however, seriously affected the animals and was accompanied by death in a large percentage of those in which the total fall in red cells was greater than 50 per cent.

The LD50/30-days dosage was found to be 4.3 microcuries of P^{32} per gram of weight. Injections of an amount less than this had no observable permanent effects on the injected animals. Injections of greater amounts caused increasingly more serious effects and resulted in death to an increasing percentage of animals.

The proportion of neutrophils was decreased by irradiation. In contrast, the percentage level of lymphocytes increased. The lymphocytes of irradiated animals characteristically included large numbers of immature forms.

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